NUTRITION

IN

EVERYDAY PRACTICE

THROUGH THE EFFORTS OF THE COMMITTEE ON NUTRITION OF THE CANADIAN MEDICAL ASSOCIATION A SERIES OF ARTICLES ON NUTRITION OF PRACTICAL VALUE TO THE PHYSICIAN IN HIS EVERYDAY PRACTICE HAS APPEARED IN THE CANADIAN MEDICAL ASSOCIATION JOURNAL DURING 1938-1939. IN THE BELIEF THAT THE COLLECTION IN BOOK FORM OF THIS SERIES OF ARTICLES WOULD PROVE OF VALUE TO ALL PHYSICIANS OF CANADA, THIS BOOK IS ISSUED.

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FOREWORD

THE PHYSICIAN'S RESPONSIBILITY FOR NORMAL NUTRITION

NO science has made greater advances during the past twenty-five years than that of human nutrition. Before 1912 the physician's main concern was to see that his patient received a proper supply of fats, carbohydrates and proteins; very little was known of the importance of the minerals, and the word "vitamin" was then unknown. Now we know that of the twenty-two amino acids commonly present in protein ten are essential, and life could not exist without thirteen minerals and at least seven vitamins.

In the past the goal of the physician and public health worker has been to see that the population enjoyed average health and did not suffer from under-nutrition or marked malnutrition. Recent observations on animals show that, starting with a diet already considered adequate, the feeding of additional amounts of certain food elements increases the rate of growth of the animals, maintains their youthful appearance longer, and lengthens their span of life. Carefully conducted studies in Canada have indicated that our present dietary customs may result in many persons not receiving amounts of some of the food elements commensurate with the highest attainable level of health. Unfortunately, the practical application of facts concerning nutrition has not kept pace with our increasing knowledge. The practising physician is so absorbed with the problem of diagnosis and treatment of disease that frequently the question of diet is more or less pushed into the background. The physicians of Canada must increase their interest in this problem of normal nutrition, otherwise the public will seek information on this subject elsewhere.

The Canadian Medical Association has long been interested in this subject, and this interest has crystallized in the formation of a Committee on Nutrition. With the view of presenting very briefly and in a practical manner proved facts concerning what the normal person should eat, and the reasons why, the Committee obtained for the *Canadian Medical Association Journal* a series of short, practical, authoritative articles on normal nutrition, which appeared regularly for eighteen months. This was done in the belief that the physician could apply these facts with benefit to every patient who consults him for any cause.

It is hoped that the efforts of the Committee will result in a more general application of our present knowledge of normal nutrition by the physician in his everyday practice. This, combined with an increased interest of the lay public in the subject of nutrition and a desire on their part to obtain authoritative information free from fads and fallacies, will result in a higher level of health for the Canadian people.

⁂

CALORIES AND OCCUPATION*

By I. M. Rabinowitch

Montreal, Que.

I.

> "From the use of materials arise
> physical results, such as work . . .
> which we can express in heat units."—Voit.

Work cannot be performed without expenditure of energy. In fact, there can be no change of any kind without free energy, and energy does not come from nowhere; wherever it is active it must have been potential elsewhere. Man obtains his energy from his food. Expressed in terms of heat units, the average value of 1 g. of carbohydrate is 4.1 calories; 1 g. of fat yields 9.3 calories; and the energy value of 1 g. of protein is 5.3 calories. An appreciable portion of the protein molecule is, however, not completely oxidized by the human body. Its value, therefore, as a source of energy is only about 4.1 calories per g.

Normal adults of similar age, sex, weight and height, when at rest, and after having been deprived of food and fluids for twelve hours or more, show a remarkable similarity in their expenditure of energy. The chemical and physical changes which account for the expenditure of the energy under these conditions of rest and abstinence from food and fluids are generally grouped under the term "basal metabolism". *Basal* metabolism must not, however, be confused with the *lowest* metabolism; the energy expenditure during sleep, for example, is still lower. The so-called basal metabolism is, however, a valuable base-line for calculating the needs of the body under different conditions of activity in health and in disease.

The expenditure of energy by the body depends to a very large extent upon active protoplasmic mass and the greater part of this mass is in the muscles. When engaged in any occupation, therefore, the primary factor which governs the need for food is the degree of muscular activity—such factors as personal idiosyncrasy and the amount and type of food eaten are minor considerations. Women need less food than men, largely because they are, as a rule, smaller and less muscular. Their "man-value" has been estimated to be about 0.83 (Cathcart and Murray), though it has been also found to be as low as 0.7 (Abrahams and Widdowson).

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Compared with the many variables which must be considered in estimating the requirements of such food elements as calcium, phosphorus, protein, vitamins, etc., determination of the minimal and optimal caloric requirements for any given occupation is simple. Data of a variety of conditions of activity are now available (Atwater and Benedict, Becker and Hamalainen, Carpenter, Lusk, Rose, etc.). The following is an example of the necessary calculations to determine the average daily caloric requirements of a metal worker:

	Calories
8 hours at work at 240 calories per hour	1,920
6 " of sitting at rest at 100 calories per hour	600
2 " " light exercise at 170 calories per hour	340
8 " " sleep at 65 calories per hour	520
Total	3,380

This approximates very closely the consumption of food materials by factory workers in Canada (Langworthy). The reliability of such data is seen in the remarkable similarity of amounts of food consumed by different people engaged in the same occupation but in different countries. Thus:

Farmer in Connecticut	3,410
" " Vermont	3,635
" " New York	3,785
" " Mexico	3,435
" " Italy	3,565
" " Finland	3,785

The above calculations, though very useful, have their limitations. Even the basal metabolism of the individual is not fixed; like most biological reactions it may, and as a rule does, vary not only in different people but also in the same individual. "Standard" diets are, therefore, meant to be used, and should be used, as *guides* only and not as *fixed* rules. "Standard" diets are *probable* requirements only; they are based upon averages obtained from many observations. They are, therefore, statistical standards and may or may not, and need not necessarily, apply to the individual. This is a fundamental fact of importance in nutrition and cannot be emphasized too often. In individual cases body weight is the best guide.

The total intake of food is not the only factor to consider in estimating caloric requirements, even when the diet is adequate with respect to all of the other elements mentioned—vitamins, minerals and protein. Maximum muscular efficiency (ability to perform any occupation with a maximum economy of food) is influenced to an appreciable extent by the source of the energy. Fatigue, for example, may be due not to lack of food but to lack of carbohydrates; muscular work is performed most economically when the greater part of the energy is derived from such food materials.

Physical efficiency may be improved in another way without increasing the total number of calories. To Haggard and Greenberg (Diet and Physical Efficiency, Yale, 1937) Industry owes a debt of gratitude. These authors have clearly demonstrated that diminished productivity, heretofore attributed to fatigue, may in reality be due to diet and overcome not by increasing the total amount of food but by more frequent meals; a fall in productivity in the late hours of the morning and afternoon may be controlled very appreciably by small amounts of food in the form of carbohydrate. The objection that the stomach has no opportunity to rest with such frequent feedings is met by these authors with the observation that there is no evidence that the stomach needs rest, or that it ever rests even when empty. Attention is drawn to the fact that convalescents, invalids, and sufferers from gastric ulcer are fed not at long intervals, to rest their weakened or diseased stomachs, but in small amounts at frequent intervals. It is *large* meals and not *frequent* meals that put a burden on digestion and cause lassitude and disinclination for thought or work. The work of these authors fits in with the marked improvement noted previously by the writer amongst diabetics soon after their diets were made more liberal with respect to carbohydrates, and when, in addition to the usual three meals a day, some food (the equivalent of 20 g. of carbohydrate) was given in the late morning and late afternoon.

Physical efficiency may be improved in another way without increasing the total number of calories, that is, by preventing hunger, or as Carlson put it, the accessory phenomena of hunger. Hunger is a sensation which arises from contractions of the musculature of the stomach. In the child these contractions may be sufficiently powerful to cause pain. In the adult, though not sufficient to cause pain, they may cause irritability, weakness and diminished ability to concentrate. A number of conditions cause hunger contractions aside from lack of food, and one is the degree of emptiness of the stomach. Fluidity of the food is, therefore, a factor. It is, for example, a well-known fact that fluid diets, though they may be very rich in calories, are not as satisfying as solid foods. Fluids and semi-fluids tend to leave the stomach almost immediately; carbohydrate foods remain for shorter periods of time than meats, and lean meats leave the stomach more rapidly than fatty foods. Aside from their direct effect upon the musculature (their ability to slow gastric mobility) fats are satisfying because they go into solution very slowly. One-half pound of steak is much more "satisfying" than one quart of milk, though the latter has about 100 more calories. Water when taken on an empty stomach passes rapidly through the pylorus; when taken with food its passage is delayed. This explains to a large extent the pleasure of afternoon tea taken with toast.

It is possible to increase efficiency without increasing the calories in a number of other ways. There is, for example, an *optimum speed* for each occupation, that is, a speed beyond which the energy consumed is out of all proportion to the useful work accomplished. Walking to and from work is an example. Walking one mile at the slow rate of 2 miles per hour requires about 60 calories only; whereas, walking at the fast rate of 5 miles per hour, one mile consumes about 600 calories; that is, increasing the speed 2½ times is so wasteful that the energy expenditure instead of being increased 2½ times is increased over ten times. (Calculated from data in "Living Machinery", by A. V. Hill, Harcourt, Brace, 1927).

Occupation, diet and income are intimately related. The physician, with his knowledge of food values, may, therefore, be of assistance here also. At its best, the human machine is wasteful; the efficiency of human muscle is approximately 20 per cent only; in the untrained individual it may be appreciably less. Very little can be done about this inherent defect, but much may be done otherwise. A fruit jelly made of gelatine, the juice of one lemon, and a portion of raw fruit has a heat value of about 30 calories only—an amount of energy which a person weighing 150 pounds expends in about one-half hour during sleep. The plebeian bread and butter pudding, made of two slices of bread and butter, one egg, ½ pint of milk and sugar to taste, has a fuel value of 500 to 600 calories—enough to meet about 25 per cent of the total daily expenditure of energy in sedentary occupations. About one-eighth of steak, as purchased, consists of fat. By removing this small percentage of fat, the steak loses about half of its fuel value. The caloric value of one ounce of clear fat pork is equal approximately to two pounds of cabbage, and one ounce of olive oil is equal in energy value to about three pounds of lettuce. Of eighteen different proprietary foods the compositions of which are known to the writer, and the fuel values of which range from 11 to 122 calories per ounce, not one may be purchased for less than eight times, and in one instance over one hundred times, the cost of similar food materials easily prepared at home.

Restricted in scope by the limit of space, the object of this article is to outline as briefly as was thought consistent with clarity some of the more important facts about caloric contents of diets—the different values of food materials; how energy requirements for different occupations may be calculated; the limitations of these methods; and how physical efficiency may be improved without increasing the number of calories in diets. Examples are also cited of the importance of knowledge of caloric values of food materials from the point of view of economics otherwise. When read in conjunction with the articles which are to follow on the subject of nutrition, it is hoped that this outline will form a practical basis for the intelligent prescription of food materials.

PROTEIN REQUIREMENTS IN NORMAL NUTRITION*

BY LENNOX G. BELL

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II.

The protein requirement in the normal diet is a subject upon which a wide difference of opinion exists, and many of the ideas are so much at variance with the known facts that these requirements should be emphasized in any discussion of normal nutrition.

In prescribing normal diets the relative proportions of fat and carbohydrate may be varied within wide limits so long as the total caloric requirements are met. In the case of protein, however, the optimum requirements cannot be supplied so simply. Protein plays a fundamental rôle in the body. Primarily, it supplies the necessary amino-acids for growth and repair of tissues, and for the manufacture of certain secretions, antigens, hormones, antibodies, enzymes, etc. In the second place, protein may be used to furnish energy through its deamination and transformation to carbohydrate. A third and perhaps less important function of protein is concerned with the transport of fats and other lipoids in the body.

Proteins are nitrogenous compounds formed of a number of amino-acids which combine in several different ways to form a wide variety of proteins, both animal and vegetable. Some twenty-two amino-acids occur in varying amounts in animal and vegetable proteins. It has been established that whereas certain simple amino-acids like glycine and alanine can be synthesized in the body others must be supplied in the diet if normal health and growth are to be maintained. There is experimental evidence to indicate that ten amino-acids cannot be synthesized by the higher vertebrates. Certain proteins such as lactalbumin of milk, beef protein, ovalbumin of eggs, glutenin of wheat, contain all the essential amino-acids, and since in the average mixed diet some or all these are supplied, only in the case of freak vegetable diets will actual qualitative deficiency arise.

The reserve or deposit protein amounts in the adult human body to approximately 2 kg. Though its fuel value is only 8,000 calories, about sufficient to maintain life at a basal level for five days, nevertheless, with its associated water (10 kg.), it forms a considerable part of the non-skeletal structure of the body. But, though available as reserve fuel in case of necessity, this protein probably serves the more important protective purpose of maintaining the stock of materials available to replace the wear and tear on vital organs such as the heart, thereby avoiding the destruction of less essential living protoplasm to protect them. It is associated with the state of turgor of tissues and, in general terms, with the sense of fitness of the body, with the power of resistance to infections, etc. In fever, starvation and wasting disease it falls to a low value, but is present in excess in myxœdematous states. It should be noted that in children not only is the reserve smaller but the rate of metabolism is higher, hence the more rapid wastage of the body as compared with adults when afflicted with the same disease.

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When sufficient calories are otherwise provided muscle-activity has little effect on the protein requirement. Only when the calories are inadequate is protein called upon to supply the deficiency. During fasting most of the energy required for muscle work is derived from fat, only 3 per cent being obtained by breaking down protein. The notion, frequently encountered, that a high protein diet is essential for heavy work in fallacious, and, indeed, in temperate weather actually mischievous, since the high specific dynamic action of the metabolizing protein causes conversion of considerable amounts of energy directly into unnecessary heat which must be dissipated. By contrast, the specific dynamic action of burning fat and carbohydrate is small. During exposure to cold weather the increased heat production induced by protein metabolism may be useful when the total energy requirement for work is small, but in the heavier outdoor occupations it is unnecessarily wasteful.

Every normal diet must include a certain quantity of proteins of sufficient variety to supply all the necessary amino-acids. Protein rich foods are enormously more expensive than carbohydrate foods; hence the economic factor enters into the question in planning normal diets. It is of considerable importance to know as accurately as possible what are the protein requirements of the normal diet. Carl Voit, in 1881, using the statistical method of studying normal diets, established the average protein intake as 118 grams daily. Professor Chittenden at Yale, in 1904, using as subjects active soldiers and athletes, was able to maintain nitrogenous equilibrium on diets containing 40 grams of protein. Today it is generally accepted that about *60 grams of protein, or, roughly, 1 gram per kilogram of body weight, represents an adequate protein intake*, and 1.25 to 1.5 grams per kilogram is commonly used in middle-class dietaries. For growth and the higher rate of metabolism of children larger allowances must be made.

During the war many observations were made in Central Europe on large groups of people who were receiving insufficient food. Many cases of anæmia and hunger œdema due to lowering of the blood proteins were studied. Yet it was observed by Muller that the protein deficiency symptoms entirely disappeared if adequate carbohydrate was added to the diet. These observations illustrate the protein-sparing action of carbohydrate, later confirmed experimentally, among others, by Rubner, who was able to maintain nitrogenous equilibrium on 33 grams of protein as long as the total calories equalled 2,000 daily. This protein-sparing action is not possessed by fats when fed alone, though fat and carbohydrate mixtures function fully as well as carbohydrate alone.

The problem of protein malnutrition is not encountered only during war and famine. Practitioners meet it daily among poor and ignorant people, and perhaps almost as frequently among the opinionated and ignorant followers of some dietary faddist or commercialized diet racketeer. Suffice it to say, then, that problems of protein nutrition will arise under conditions causing an insufficient intake or inadequate absorption of the protein or other foods, whenever the protein loss is abnormally large or there is reason to suspect that increased destruction of protein is taking place, or whenever the body is unable to replace the broken-down protein with sufficient speed.

It will be readily apparent that the protein intake for normal nutrition and growth will vary with the age of the individual as well as with his size. Holt and Fales suggest 4 grams of protein per kilogram body weight up to one year of age, the requirement diminishing gradually, until at six years 2.6 grams per kilogram body weight is sufficient. The requirement may be more simply expressed as that protein contained in 2 ounces of milk (1.8 grams protein) for the first year, and thereafter 1.5 ounces of milk for each pound of normal body weight. Indeed this standard might be accepted as providing sufficient protein up to twelve, even fifteen years of age, when the requirements for growth diminish. During adolescence 0.9 ounces of milk should be adequate and 0.8 ounces thereafter would provide liberal protein for the adult.

Milk, however, as a permanent diet has many obvious disadvantages which these calculations have for the moment ignored. It should furnish 100 per cent of the protein for the first four months of life and 90 per cent of the protein for the remainder of the first year. For the next seventeen years, 30 ounces of milk (27 grams protein) should be supplied, and thereafter a minimum of 10 ounces of milk daily is desirable. This includes the amounts used in cooking. The remaining protein may be obtained from other sources, but up to six years of age the diet should contain at least two-thirds of its protein in the form of Grade A protein (meat, eggs, fish, fowl and dairy products). Thereafter, from 35 to 50 per cent of the protein intake should be Grade A, the remainder being derived from as wide a variety of sources as possible.

From the Table it is simple to ascertain the approximate protein sufficiency of a diet. Thus one serving each of milk, eggs, and roast beef, with three servings of bread, contain 1,100 calories and 54 grams protein, four-fifths the protein requirement of the average man, and over 70 per cent of it is Grade A protein.

TABLE

Source of protein	*Raw or cooked*	*Average serving*	*Protein in serving*	*Grade of protein*	*Fat*	*CHO*	*Calories in serving*	*Calories per pound*
		oz.	*gram*		*percentage*	*percentage*		
Beef, roast	C	2½	17.0	A	28.0	..	257	1,512
boiled	C	3	22.5	A	23.0	..	276	1,380
corned	C	3	24.0	A	19.0	..	247	1,235
small sirloin	C	5	36.0	A	10.0	..	279	837
tongue	C	1½	8.5	A	23.0	..	127	1,270
Veal, roast leg	C	3	25.0	A	1.0	..	109	545
cutlet	C	4	24.0	A	7.0	..	171	641
Bacon, side	C	1½	6.8	A	40.0	..	189	1,890
back	C	1½	9.9	A	33.0	..	173	1,732
Ham	C	2	13.2	A	33.0	..	231	1,732
Pork, roast leg	C	2½	21.0	A	10.0	..	151	909
chop, lean	C	2½	20.0	A	6.0	..	119	711
Lamb, roast leg	C	2½	15.0	A	13.0	..	147	827
chop	C	2½	13.8	A	26.7	..	235	1,408
Chicken, roast	C	3	22.5	A	5.0	..	130	612
Turkey, roast	C	2½	20.9	A	18.4	..	210	1,295
Salmon, boiled	C	3+	19.6	A	7.5	..	146	680
Halibut, boiled	C	3+	21.4	A	4.0	..	120	540
Mackerel, boiled	C	3+	23.7	A	6.5	..	153	688
Trout, lake	C	3+	18.0	A	10.0	..	162	729

Oysters	R	3+	6.0	A	1.0	3.0	45	202
Eggs, two	R	3	12.0	A	6.0	..	156	780
Milk	R	10	9.0	A	4.0	5.0	204	306
Cream, table	R	5	4.0	A	16.0	3.8	255	850
whipping	R	5	3.0	A	32.0	3.8	451	1,503
Cheese, domestic	R	2/3	5.6	A	38.0	..	91	1,943
Ice cream	R	3+	5.2	A	10.0	18.0	189	850
Bread, wheat	C	2	5.4	B	1.0	55.0	160	1,192
rye and wheat	C	2	7.2	B	..	52.0	160	1.190
Oatmeal, boiled	C	3+	2.8	B	0.5	11.5	61	274
Shredded Wheat, one	C	1	3.0	B	0.4	75.0	109	1,744
Puffed rice	C	½	0.9	B	..	80.0	54	1,575
Cornflakes	C	2/3	1.1	C	1.5	81.0	72	1,640
Macaroni	C	3+	3.0	B	1.5	15.8	91	410
Peas, green	C	3	6.0	B	3.0	13.5	110	536
Beans, canned, baked	C	4	8.0	B	3.0	22.0	173	649
Corn, canned, green	C	3+	2.8	C	1.2	19.0	101	455
Calf's foot jelly	C	2	2.5	C	..	9.0	54	89
Jellied meats	C	3	13.0	AC	2.5	..	74	370
Meat and vegetable stew ..	C	5	7.5	AC	5.0	5.0	127	381

NOTE: + equals less than half an ounce, *i.e.*: 3+ equals 100 grams.
Grade A proteins, excellent replacement and growth value.
Grade B proteins, good supplementary protein.
Grade C proteins, incomplete: never to be used as the major protein of the dietary.

THE NUTRITIONAL SIGNIFICANCE OF FAT*

By R. G. Sinclair

Kingston, Ont.

III.

Fat as a Source of Energy

Weight for weight, the fats are a much richer source of energy than either the proteins or carbohydrates. This is due to several factors: the higher percentage of carbon and hydrogen; the relatively "dry" state of fat as compared with the high water content of the carbohydrates and proteins as they are ordinarily eaten; and the more complete digestibility of fat than of crude carbohydrates and proteins. The superiority of fats in this respect is of considerable practical importance. Man is by nature an omnivorous creature, and, as has been pointed out by Starling, the human alimentary tract is best suited to the digestion of relatively concentrated foodstuffs in which fat makes up 20 to 25 per cent of the energy content. Provided the energy requirement is moderate, a man can get along quite well on a very low fat diet. Indeed an experiment has recently been reported in which a man maintained himself for six months on a diet which provided only about 2 grams of fat per day. Subjectively, "the most noticeable feature was the marked absence of fatigue." However, in this case the diet used was specially selected and consisted mainly of skimmed milk, sugar and starch. If, on the other hand, one is forced to get along on a low fat diet, consisting mainly of the usual crude high carbohydrate foods, such as the cereals, and especially if required to do hard manual labour, then the observations are quite different. Based on the experiences in Britain and the central European countries during the World War, when fat consumption was greatly restricted, the low fat diets resulted in premature hunger, a reduced capacity to do sustained work, and in general a reduction in the energy intake below the usual maintenance level. It has been claimed that a high carbohydrate diet low in fat leads to excessive fermentation in the intestinal tract with resultant discomfort and disability.

There is considerable difference of opinion as to the optimum level of fat intake. For the average adult, about one-third of the calories seems to be a suitable level. However, it depends a good deal on the occupation. The harder the work, the greater is the energy requirement and the greater is the need for the more highly concentrated high fat diets.

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IS THE NATURE OF THE FAT IN THE DIET AN IMPORTANT FACTOR?

Several years ago it was clearly shown by Burr and his coworkers that normal growth and well-being of the white rat requires the presence in the diet of certain unsaturated fatty acids which were best supplied by corn and linseed oils. It is noteworthy that butter, one of the important sources of fat in the human diet, does not satisfy the requirements of the rat unless fed at moderately high levels. These findings naturally raised the question of their bearing on human nutrition. Do human beings suffer from a deficiency of unsaturated fatty acids, and, if so, what are the symptoms? The experiment described above, in which a man lived for six months on a low fat diet, was specifically designed to put this to the test. No untoward results were observed. On the other hand, it has been reported that the feeding of unsaturated fats has a beneficial effect on certain human ailments.

It was observed that excessive scaliness of the skin of rats, especially that on the feet and tail, was a characteristic symptom of the so-called "fat deficiency" disease. It has been definitely shown that the fatty acids of the blood of children with eczema are on the average less unsaturated than those of the blood of normal children. Since this holds even when the eczematous and normal children have been kept on the same diet for several months, it would appear that the deficiency of unsaturated acids in eczematous children is due to some defect in the utilization of the unsaturated acids normally present in the diet. In 1933, Hansen reported that the administration of oils rich in unsaturated fatty acids to two infants suffering from eczema produced definite clinical improvement. Some other observers have reported favourably on this administration of unsaturated fatty acids to infants with eczema. Their results, however, have failed to find confirmation at other clinics.

Recently, Boyd and Connell have reported results which suggest that the administration of unsaturated fatty acids improves the resistance of human beings to the common cold. The experiment was carried out on a group of 41 students who reported the number and duration of colds incurred over two successive periods of seven weeks each, during the second of which they received 15 minims of an unsaturated fatty acid concentrate. The data showed a reduction in both the number and duration of colds during the treated period. Another group of 65 untreated students showed no appreciable reduction in colds during the same period. However, this group was made up of non-susceptible persons who had comparatively few colds in either period. In view of the rather small number of subjects and the inability to control such factors as diet, exposure to sources of infection, weather conditions, etc., these results must be regarded as merely an indication that the susceptibility of certain people to common cold may be due to a deficient intake of unsaturated fatty acids. On further individual cases of susceptible persons the authors have observed beneficial results from the treatment, but they recognize the need for a thorough and well-controlled study on a large group (personal communication).

NATURAL FATS AS A SOURCE OF VITAMINS

Since vitamins A, D and E are fat-soluble substances they occur under natural conditions in association with the fats. However many of the common food fats, *e.g.*, pork fat and vegetable oils, contain insignificant amounts of the fat-soluble vitamins. It is now well recognized that the diet, especially in the case of growing children, should be supplemented with fish liver oils in order to insure an adequate intake of vitamin D.

DOES FOOD FAT HAVE HARMFUL EFFECTS?

It has sometimes been thought that diet, especially its fatty constituents, plays a part in the development of arteriosclerosis in human beings. Definite evidence of this is still lacking. It is true that in rabbits atherosclerosis can be produced experimentally by feeding cholesterol dissolved in fat. Such a diet produces a pronounced increase in all of the blood lipids. Since an increase in the blood lipids has also been found to occur very often in diabetes, and since uncontrolled diabetics show a high incidence of arteriosclerosis, the view has been advanced that there is a causal relationship between fat in the diet, the level of the blood lipids, and arteriosclerosis. However, it has been abundantly shown in recent years that diabetics under good control do not show an increase in blood lipids above the normal range, even if the diet is of a distinctly high fat type. Further, in persons who died from accidental injury there was no correlation between the degree of atherosclerosis and the level of the blood cholesterol. As Wyckoff has put it, "one fails to find a basis for thinking that there is a relation between arteriosclerosis and diet".

On the other hand, diet has been shown to be a very important factor in certain cases of essential xanthomatosis, in which there is an accumulation of cholesterol under the skin and in the tendon sheaths. Cholesterol, the sterol present in animal tissues and such animal products as milk, cheese and eggs, is readily absorbed from the intestinal tract. The phytosterols, the sterols of plants, because of a slight but important difference in chemical composition are not absorbed but are excreted in the fæces. Rigorous restriction of foods containing animal fats from the diet of persons suffering from essential xanthomatosis in some instances results in definite clinical improvement.

THE CHOICE OF FOODS FOR THEIR FAT CONTENT

As a general rule, the choice of foods by the providers of the individual families is bound to be governed by such factors as economic status, personal preference, season of the year, and the variety offered by available markets. Naturally the same factors influence the relative proportions of protein, carbohydrate, and fat in the diet and the source of the fat used. The prejudice of many people against the margarines as substitutes for butter is based largely on fancied differences in flavour. In terms of calories, the edible fats on the market are all the same. Being cheaper to produce than animal fats, the processed vegetable fats yield better value for the money.

The provision of the required number of calories is by no means the only requirement of an adequate diet. Recent developments in the field of nutrition have further emphasized the fact that many people may be suffering from a deficiency of the essential vitamins or minerals, even though their caloric intake is sufficient for their needs. And since fat meats are practically devoid of vitamins, one must be especially on the lookout for deficiency diseases among people who, for economic reasons or because they live in isolated communities, are forced to live, especially during the winter months, on simple diets made up for the most part of fat pork and potatoes.

In devising diets of either high or low fat content it will be helpful to remember that 1 g. of fat equals in calories 2.3 g. of carbohydrate or protein, and that the common foodstuffs can be grouped roughly as follows on the basis of fat content:

Low in fat less than 2 per cent	*Medium fat content* 2 to 10 per cent	*Rich in fat* above 10 per cent
vegetables	cream soups	butter and other fats and oils
most fruits	milk	salmon
cereals	veal	tuna
bread	chicken	lamb
egg whites	turkey	pork
buttermilk	lean beef	duck
	crab meat	goose
		egg yolks

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NUTRITIONAL REQUIREMENTS DURING PREGNANCY*

By E. M. Watson

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IV.

The nutritional requirements of the expectant mother are exactly those of any healthy woman of child-bearing age plus certain dietary reinforcements. During pregnancy the mother must be supplied not only with all the nutritional factors necessary for her own well-being but, in addition, nutritive substances for the developing offspring. The fetus *in utero* is essentially parasitic. It takes what it needs from the mother's blood stream and even draws upon the organic stores of the maternal host. Nature has decreed that the imperious demands of the unborn child be supplied regardless of the cost to the mother in terms of demineralization, loss of tissue reserves, vitamin deficiencies, and the consequences thereof.

There is evidence in favour of a relationship between nutrition and certain of the disabilities and toxæmias associated with pregnancy and childbirth. Further, the fate of the offspring is dependent in large measure upon the nutritional state of the mother before and during pregnancy. The effect of nutrition upon the maternal morbidity and mortality rates and upon neonatal and infantile mortality is recognized.

Attention to the diet, therefore, constitutes an important item in the antenatal program, and the need for careful instruction to the gravid woman with respect to her food requirements is obvious. In this regard special consideration must be given to the so-called "protective" foods, namely, the minerals, vitamins and "good" protein. The more strictly "energy-giving" foods are of relatively less significance. In the following review, the more important dietary requirements of normal, uncomplicated pregnancy are outlined.

Minerals

One of the commonest defects of modern dietaries is a faulty mineral supply, and during pregnancy the needs for calcium, phosphorus, iron and iodine are emphasized.

Calcium.—It is essential that the pregnant woman receive sufficient calcium in her food so that she will not have to sacrifice the calcium of her bones and teeth in the interests of the developing fetus. Milk is noted for the abundance and the availability of its calcium salts. A favourable calcium balance may be acquired by the ingestion of one quart of milk a day in addition to other calcium-bearing foods such as cheese, fruits and vegetables. Not only is the amount of calcium in the diet important but provision for its utilization must be assured. This involves a consideration of vitamin D, further reference to which appears below.

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Phosphorus.—Phosphorus, being more widely distributed in foods than calcium, is less likely to be deficient in the average diet. If the protein requirements and other dietary principles as outlined herein are observed the need for phosphorus during pregnancy will be met.

Iron.—The fetus absorbs a considerable amount of iron from the maternal organism for use in blood formation and in building up a reserve supply of iron which will serve the infant during the early part of its extra-uterine existence. This drain upon the mother, unless counterbalanced by the ingestion of iron-rich foods or iron in some other form, such as Iron and Ammonium Citrate or Ferrous Sulphate, may result in a more or less severe grade of hypochromic anæmia.

Sources of food iron are liver, kidney, lean meat, eggs, whole grain and lightly milled cereals, vegetables, fruits and molasses.

Iodine.—The infant depends upon the mother for its iodine compounds during the prenatal and nursing periods. Cretinism may be avoided by insuring an adequate intake of iodine during gestation. The best sources of natural food iodine are sea-water foods and fish-liver oils. Where sea fish are not available, the provision of extra iodine in the form of iodized salt or in some other way is necessary.

VITAMINS

There is a definite relationship between normal reproduction and certain of the vitamins. While the commonest deficiency is probably that of vitamin D, the demand for all the vitamins is increased during pregnancy; so relative deficiencies may supervene. An adequate provision of the vitamins, other than vitamin D, can be realized by including in the dietary sufficient of the protective foods without recourse to special products.

Vitamin A.—The chief function of vitamin A is the preservation of health and vigour, with particular reference to the condition of the mucous membranes; in this way it promotes resistance to infections. The best sources of vitamin A are whole milk, cream, butter, cheese, egg yolk, the green leafy vegetables, the yellow vegetables, liver and fish-liver oils.

Vitamins B_1.—To some extent vitamin B_1 presides over the activities of the gastrointestinal tract. An insufficiency of this factor may result in atonic constipation and impaired absorption from the intestine. Also, a marked prolonged deficiency may contribute to the so-called gestational polyneuritis.

Vitamin B_1 is provided in whole grain and lightly milled cereals, vegetables, fruits and egg yolk. Two concentrated sources of the vitamin which may be used to augment the diet are brewer's yeast and wheat germ.

Vitamin B_2.—It is possible that certain cases of macrocytic hyperchromic anæmia of pregnancy may be related to a deficiency of the vitamin B_2. This factor is contained in many of the foods mentioned above in connection with vitamin B_1, but meat and milk contain more vitamin B_2 than B_1.

Vitamin C.—The requirement for vitamin C is increased during pregnancy, and it is recommended that the diet of the pregnant woman contain a sufficiency of this substance. Rich sources are citrus fruits, tomatoes (raw or canned), apples and potatoes.

Vitamin D.—An adequate supply of vitamin D in the maternal diet is essential for the utilization of the calcium and phosphorus so necessary for the calcification of the fetal bones and teeth. The ordinary foodstuffs are notoriously poor in vitamin D, for which reason cod liver oil, or its equivalent, may be regarded as a food to be included in the daily diet of the pregnant woman. A lack of sunshine increases the need for vitamin D.

Vitamin E.—Experimental and clinical data suggest that vitamin E is necessary for the normal development of the fetus and the completion of pregnancy. While no relationship has been established between the occurrence of abortions and a deficiency of vitamin E, women with histories of repeated spontaneous abortions have prolonged their pregnancies to full term while taking concentrated preparations of the vitamin (wheat germ oil). Except in unusual circumstances, however, a diet which is adequate in other respects contains enough vitamin E to fulfil all ordinary requirements.

PROTEINS

There is some difference of opinion with regard to what constitutes the optimum intake of protein during normal pregnancy. Approximately 100 grams per day would seem to be an appropriate amount. Of greater importance, however, is the assurance that the protein foods be those of the highest biological quality, specifically, the flesh proteins derived from meats, fish and poultry, the protein of milk and milk products and eggs. If the daily food allowance provides one quart of milk, one egg, and a liberal serving of meat (muscle) in addition to the other necessities comprising a balanced diet, the protein requirement should be covered adequately. The glandular tissues (liver, kidney, thymus, pancreas) are highly nutritious as regards the character of their protein, mineral, and vitamin contents. The use of a food of this type once or twice a week in place of ordinary meat is commendable.

CALORIC REQUIREMENTS

The basal energy expenditure is increased during the second half of pregnancy, but this increase tends to be compensated by decreased muscular activity. There is rarely any need for special instruction regarding the caloric value of the diet in pregnancy. The average energy requirement throughout pregnancy is probably 2,400 calories daily, although this may rise near term. Except under extreme conditions diet has little effect upon the birth weight of the child. The real danger rests in a tendency to consume the bulk of the calories in the form of concentrated carbohydrates, with a coincident reduction below the safety level of the essential protective foods.

The physiological aspects of nutrition cannot be separated from the social and economic factors. Of all members of the population, the pregnant woman deserves the greatest nutritional "protection".

FOODS BEST SUITED FOR NORMAL PREGNANCY

Daily requirements.—

Cereals: 1 whole grain product, served as cereal, muffins or pudding.

Bread: Whole grain is best; at least three slices a day.

Milk: 1 quart to drink; also, cheese or milk dishes, once daily.

Fruits: 2 daily, 1 cooked (*e.g.*, apple sauce, prunes, apricots, pears), and 1 raw, from the citrus fruit group (oranges, grape-fruit, lemons, pineapple). Raw vegetables, as listed below, 2 or 3 times a week will replace citrus fruits satisfactorily.

Vegetables: One serving of potatoes or a substitute such as rice, macaroni or spaghetti. One or more cooked vegetables, preferably from the green leafy or yellow bulky variety, such as spinach, Swiss chard, beet greens, carrots, squash, etc. One raw vegetable, to substitute for citrus fruits.

Meats and fish: One serving daily. Liver should be served once a week at least. A meat substitute, such as beans, peas or lentils, may be chosen once a week.

Eggs: One a day as such, or used in cooking.

Desserts: Simple puddings once or twice daily, preferably milk and egg or fruit combinations.

Cod liver oil: 400 international units of vitamin D (1 teaspoonful of cod liver oil).

SPECIMEN MENUS

1. *Moderate cost diet for pregnancy—2,800 calories.*

Breakfast: Apple sauce, whole-wheat cereal, whole-wheat bread, butter, honey, milk.

Dinner: Roast beef and gravy, mashed potatoes, peas, whole-wheat bread, butter, custard pie, milk.

Supper or lunch: Tomato juice, macaroni and cheese, beet salad and egg, whole-wheat bread, butter, apricots, oatmeal cookies, milk.

(Part of the quart of milk required may be taken between meals and before retiring at night.)

2. *Low cost diet for pregnancy—2,800 calories.*

Breakfast: Thoroughly cooked oatmeal, whole-wheat bread, butter, jam, milk.

Dinner: Meat or liver loaf, potatoes, turnips, bran muffins, butter (or margarine), chocolate bread pudding, milk.

Supper or Lunch: Cream tomato soup, cottage cheese, baked potatoes, cabbage and carrot salad, whole-wheat bread, peanut butter, banana, gingerbread, cocoa.

(Part of the quart of milk required may be taken between meals and before retiring at night.)

The author is indebted to Miss Marion Penhale, of the Dietetic Department of the Victoria Hospital, London, for suggestions regarding the lists of foods and the menus.

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NUTRITIONAL REQUIREMENTS OF THE MOTHER DURING LACTATION*

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V.

Premature births and still-births are common amongst undernourished woman. When fetuses of such women do reach maturity and are born alive they are usually underweight and many die within the first ten days of life. Amongst those which survive for longer periods of time, the chances of living long, unless they are artificially fed, are greatly reduced because of the diminished capacity of the undernourished mother to produce milk. Food is, of course, not the only factor which governs the physical fitness and survival of the new-born infant; heredity plays its part—the capacity to grow is inherent in protoplasm independent of food supply. However, as Todd[1] aptly put it, the adult physical pattern is the outcome of growth, along lines determined by heredity but enhanced, dwarfed, warped or mutilated in its expression by the influence of environment in the adventures of life. One of these influences is food supply.

The possible effects of diminished capacity to produce milk upon the nutrition of the infant are suggested from the relationship between the protein contents of milk of different species and the average time it takes for these species to double their birth weights.[2] Thus:

Species	*Protein content of milk percentage*	*Number of days required to double birth weight*
Human	1.6	180
Horse	2.0	60
Calf	3.5	47
Kid	4.3	19
Pig	5.9	18
Lamb	6.5	10
Dog	7.1	8
Cat	9.5	7
Rabbit	14.4	6

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*From the Department of Metabolism, the Montreal General Hospital, Montreal, Canada.

The metabolism of lactation is not entirely a post-natal phenomenon; the preparation for this function begins practically with the onset of pregnancy but, as will be seen later, is much more active during the latter months. Some idea of the necessary preparation is suggested from a comparison of the chemical composition of the mother with the chemical composition of her new-born infant. A full term infant, weighing about 8 pounds, contains about 60 grams of nitrogen only; yet, by the time the pregnancy has reached full term the body of a pregnant woman acquires about 500 grams of nitrogen in excess of that present prior to the occurrence of the pregnancy, that is, about 800 per cent more than that which can be accounted for by the nitrogen content of the fetus. In the case of calcium the excess is about 50 per cent, and that of phosphorus is 300 to 400 per cent more than can be accounted for by the fetus.[3] The increase of weight alone suggests an appreciable storage of food materials.* Some of this excess can be accounted for by the amniotic fluid and the placenta. An appreciable portion is to be found in the increase of the uterine musculature. A part is necessary to counterbalance the marked loss which occurs immediately after birth and here we observe a somewhat similar behaviour of mother and infant. Prior to its birth the infant stores an excess of iron because of the marked destruction of blood which occurs within the first ten days or two weeks of life. Because of the poor calcium content of human milk the infant also stores large amounts of this element prior to its birth. The mother stores food materials for somewhat similar reasons. Nitrogen is an example. The retention of this element is particularly marked during the last few weeks of pregnancy, ranging from 1.4 grams a day in primiparæ to over 5 grams a day in multiparæ.[4] The storage counter-balances to a very appreciable extent the loss of nitrogen which takes place immediately after the birth of the child and which continues until about the end of the third week on account of the regressive changes. This daily loss of nitrogen may amount to as much as 4 grams or more.[5] All of these factors, however, do not account entirely for the storage of nutrient materials in the maternal organism during pregnancy. An appreciable part is to be found in the enlargement of the breasts in their preparation for the production of milk.

A fact of practical importance is that nutritional disturbances which occur as a result of inadequate storage of food in the maternal organism during the intra-uterine life of the child are very difficult to counteract after birth, in spite of very careful feeding. For example, a child whose mother suffered from osteomalacia during the pregnancy is likely to develop rickets, regardless of the satisfactory diet of the mother during lactation and use of

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*By full term, a woman weighs about 30 pounds more than before the pregnancy. The child accounts for 7 or 8 pounds. The placenta, etc., account for another 7 or 8 pounds. During pregnancy, therefore, the maternal organism *per se*, acquires about 15 pounds of weight.

supplementary diet for the child which contains all of the essential food elements.

The above examples were cited to emphasize the fact that a consideration of the nutritional requirements during lactation is incomplete without consideration also of the requirements during the preparation for lactation and the development of the fetus. Yet, according to the Children's Bureau, the nine months before a baby is born are "the most neglected period of its existence".[6]

Assuming conditions are normal for both mother and child at the end of the period of gestation, deficiencies may still occur and thus not only affect the nutrition of the mother but indirectly also that of the child. A guinea pig runs about and nibbles green leaves soon after it is born. Like other mammals, however, the new-born human infant is helpless and must obtain its entire food supply from its mother. It does not have to be taught the principles of hydrostatics to do so; but knowing how to feed and obtaining the proper nutrient materials, qualitatively and quantitatively, are not synonymous.

The nutritional requirements of a woman during lactation have materially changed in the last few centuries. In the 16th century, a mother did not wean her child until it had all of its teeth. This, as the writer has observed, is still a practice amongst some Eskimos in Canada's Eastern Arctic. Today, amongst civilized peoples, the child is generally weaned before it is one year old. This practice is compatible with the health of the child, because of the advances made in the science of infant feeding. Human milk is, however, not as yet entirely reproducible. It is, therefore, necessary to know the conditions under which the child may receive an adequate supply of milk without impairing the health of the mother.

The production of milk does not, *per se*, demand a great expenditure of energy. The rearrangement of food of the maternal organism for the preparation of milk depends upon hydrolytic changes (cleavage and synthesis) which involve hardly any thermal reactions. The secretion of the milk, like secretion by the kidneys, has also little influence upon the total energy exchange of the body. The additional food necessary for the maternal organism for the production and secretion of milk is therefore negligible. The chief consideration during lactation is, as will be noted, the loss of the food materials in the milk and storage of a certain amount of food which cannot be accounted for entirely by the chemical composition of the milk.

Human milk contains about 1.5 per cent of protein, 3.5 per cent of fat, and about 7.0 per cent of carbohydrates. One litre of such milk, therefore, has a food value of over 600 calories and a itre of milk is, approximately, the daily requirement of the child during the latter months of breast-feeding. Milk production can be forced in animals and man is no exception. Amounts as high as ,521 and 1,758 cubic centimetres have been observed with energy values of 1,269 and 1,096 calories respectively.[7] A fact of practical importance in these observations is that production of milk can be forced by a proper food supply. Equally important, however, is also the fact that the drain upon the maternal organism may be quite appreciable. For example, since human milk contains about 0.03 per cent of calcium, these subjects lost between 0.45 and 0.52 grams of calcium per day. Human milk, it was noted, contains about 1.5 per cent protein. The protein losses in these cases were, therefore, about 25 grams a day.

As a guide to the nutritional requirements of the mother during lactation, the following are, briefly, the more important facts.

1. Milk is a true secretion; it is the product of the cellular structure of alveoli of the mammary gland. As stated, its production requires little energy and, like the kidney, its secretion does not involve an appreciable expenditure of energy. However, the food requirements of the mother are not to be judged entirely by the food value of the milk; proper production of milk is accomplished only by simultaneous storage of similar food materials in the maternal organism. Without such storage either the amount of milk is reduced or the mother loses weight.

2. The food requirements are not uniform during the entire period of lactation. When one week old a child may consume about 15 ounces of milk during 24 hours; whereas three weeks later it may consume twice this amount. Milk production tends to reach its peak between the 25th and 30th week. This is shown in the weekly consumption of calcium by the nursing infant (Rose*). Thus:

Age of infant (months)	*Weekly consumption of calcium (grams)*
3	1.9 to 2.2
6	2.5 to 2.7
9	2.7 to 3.0

Failure to recognize these changes in milk production and, therefore, the changes in the nutritional requirements of the mother may account to quite an extent for losses of weight of the maternal organism at these periods.

3. The caloric needs of the mother are met with by allowing, in addition to the mother's own needs, approximately 60 calories per day for each pound of the infant's body weight during the first three months; about 50 calories during the second three months and about 40 during the third. These are liberal values, since very few children are now entirely breast-fed. A number of

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*The calcium content of human milk ranges within very narrow limits. The total grams of calcium, therefore, afford a reliable indication of the volume of milk consumed.

means of conserving calories were outlined briefly in the first of this series of articles.[8]

4. An adequate supply of protein is assured by supplying about 2 calories in the form of protein for each protein calorie present in the milk. The protein should, however, have the highest possible biological (protein-sparing) value and, therefore, should be in the form of milk, eggs, fish and meat. Although liberal servings of bread and other cereals are desirable as sources of energy, no reliance should be placed upon these food materials as sources of protein because of their relatively low biological value.

5. A deficiency of calcium during lactation is more likely to occur than of any other of the food elements.* A minimum of one quart of milk a day, supplemented by an average portion of cheese once or twice a week, combined with eggs and green vegetables will, however, ensure an adequate calcium intake. Cod liver oil is an additional safeguard since it enhances the utilization of calcium (and phosphorus).

6. It appears that the bovine organism may be capable of synthesizing vitamin C. There is, however, no evidence that the human being can do so. A liberal serving of fresh citrous fruits twice a day or, if necessary, canned tomatoes protects against this deficiency. The modern methods of canning do not destroy this vitamin.

7. A liberal serving of vegetables twice a day is desirable. Half of it should be raw.

8. With the above liberal amounts of milk, meat, eggs, fruits and vegetables, no special precautions are necessary to meet the requirements with respect to all of the other vitamins. The total mineral requirements will also be met satisfactorily.

9. The total daily intake of fluids should be no less than two quarts; more is desirable. Such amounts tend to increase the volume of milk. As stated, although the chemical composition of milk differs in different species it is fixed within narrow limits in each species. No increase of calcium in the diet, for example, can appreciably increase the percentage of calcium in the milk. Since human milk is poor in calcium an adequate supply for the child is, therefore, obtainable only by increasing the volume of the milk.

10. Lactating women tend to become anæmic, not only because of a deficiency of iron in the diet but because of impairment of the mechanism of utilization of this mineral due to the tendency towards defective production of gastric secretion during pregnancy. Large amounts of iron tend to counteract this tendency and are assured by the above-mentioned liberal use of eggs, green vegetables, etc. A fact also of practical importance is that prevention of iron deficiency is dependent not only upon the amount of iron

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*This was strikingly shown in dairy cows; when bred to a high producing capacity (20 to 27 pounds per day) calcium equilibrium could not be maintained by diet and adequate sunlight alone; additional quantities of anti-rachitic vitamins were required (Hart, E. B., *et al.: J. Biol. Chem.*, 1926, **67**: 371).

in the food but also upon the form in which the iron is supplied. Judging from the rate at which hæmoglobin is produced, the combination of bread and eggs or bread and meat—particularly liver and chicken gizzard—appear to be the most satisfactory. Utilization of iron is also influenced to some extent by the calcium content of the diet. An adequate intake of calcium, therefore, serves another purpose.

11. Finally—and it cannot be emphasized too often—a consideration of the nutritional requirements during lactation is incomplete without a consideration also of the nutritional requirements during the period of the preparation for lactation; the proper time to prevent deficiencies is not after the child is born, but soon after the onset of pregnancy.

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VITAMINS IN INFANCY AND CHILDHOOD*

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VI.

Experimental work with animals gives evidence that there are no less than 15 different vitamins. However, only 7 of these are well recognized—vitamin A, three members of the vitamin B complex, namely, B_1, riboflavin, and nicotinic acid, and vitamins C, D, and E.

Vitamin A.—A complete or marked lack of vitamin A results after some 2 to 4 months in the development of an eye condition called xerophthalmia. In this disease the eye has a peculiar ground-glass appearance and corneal ulcers appear. If the patient is not treated with vitamin A the ulceration will proceed, with final destruction of the eye. Fortunately this condition is extremely rare in Canada. In the last million attendances at the Hospital for Sick Children, Toronto, only one case of xerophthalmia has been noted. A partial lack of vitamin A causes the condition known as night-blindness, that is, a patient is unable to adjust his vision to changes in light intensity, such as occur when going from a bright room to a poorly lighted room. With a lack of vitamin A the columnar cells of the mucous membranes throughout the body gradually become squamous in character. This interferes with their normal function.

The exact vitamin A needs of both children and adults are unknown. However, of all the vitamins vitamin A is the most widely and abundantly distributed. It is present in large amounts in the fat of milk (milk, cream and butter), coloured vegetables, such as carrots, spinach and tomatoes, and in egg, liver and kidney. There is no evidence to indicate that if the child is receiving a reasonable diet it will suffer from a lack of vitamin A, or require additional amounts in concentrated form.

Vitamin B_1.—The story for vitamin B_1 is entirely different from that for vitamin A. Vitamin B_1, or thiamin, is widely but not abundantly distributed in foods. Our most concentrated food source is wheat germ, which, unfortunately, is carefully separated in our modern milling process, the white flour being reserved for human consumption and the germ used largely in animal feeds.

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This constitutes a great loss of this vitamin to the Canadian people. Another excellent source of vitamin B_1 is yeast, which of course can hardly be considered an ordinary food. We get vitamin B_1 in small amounts in milk, egg-yolk, liver, kidney, in many vegetables, particularly peas and beans, and traces in many fruits. Due to the wide use of finely milled flours and sugars 35 to 45 per cent of the calories ordinarily consumed by the older child and adult contain practically no vitamin B_1. In addition, as vitamin B_1 is water soluble, investigations show that a large proportion of this vitamin in vegetables may go into solution in the cooking water and be discarded. For these reasons, one would expect some evidence of a lack of vitamin B_1 in the Canadian population.

A lack of this vitamin results in the disease beriberi or polyneuritis. This disease is rarely seen in Canada. One of the prominent symptoms of a lack of vitamin B_1 in animals is loss of appetite and the development of atony of the intestinal tract. There is evidence that in some instances these symptoms occur in human beings as a result of a deficiency of this vitamin. Also it has been found that with two groups of children living in an orphanage and both fed exactly the same diet, which according to our Canadian standards was a good one, the daily addition of a small amount of vitamin B_1 concentrate to the diet of one group resulted in an increased gain in weight in the children in that group. This would indicate that possibly the diet without the addition of the vitamin B_1 did not contain the optimum amount of this vitamin.

The physician should watch carefully his patient's diet from the standpoint of its vitamin B_1 content. Although vitamin B_1 is not present in high concentration in milk, this food is really an important source of it owing to the relatively large amounts of milk consumed. To illustrate this point, one and one-half pints of milk supply approximately 200 international units of vitamin B_1, with the total daily requirements 400 to 500 units. Vegetables should be used freely and the cooking done with a minimum amount of water so that the loss from solution in discarded cooking water is reduced to a minimum. The use of whole grain cereals egg, liver and kidney will also help to supply appreciable amounts of vitamin B_1.

Vitamin B_2, or riboflavin.—In 1926 it was demonstrated that what was then called vitamin B consisted of two parts, and one was called B_1 and the other B_2. Experimental work since that time has shown that vitamin B_2 really consists of a number o different components, and of these two have been isolated and are well known, namely, riboflavin and nicotinic acid.

Riboflavin is necessary to maintain life in animals, and a lack of it results in lack of growth and a premature ageing of the skin with loss of hair. Unfortunately, the exact place of riboflavin in human nutrition has not been demonstrated, but there is no doubt in the minds of the investigators who have worked with this food substance that if it were lacking in the human diet serious results would follow. Its distribution follows to a degree that of vitamin B_1, although in many foods it seems to be more abundant. If a diet contains an adequate amount of vitamin B_1, it is probable it also contains an adequate amount of riboflavin.

Nicotinic acid.—This acid has been known to chemists for over seventy-five years, yet no one suspected that it was of any importance in nutrition until September, 1937, when Elvehjem reported that the administration of nicotinic acid cured a disease in dogs known as black tongue. Following this work by Elvehjem, Spies in November, 1937, reported that the administration of nicotinic acid to patients with pellagra resulted in spectacular cure of the mucous membrane lesions and a gradual improvement in the whole condition of the patient. This work has been amply confirmed by many workers. Fortunately, pellagra is practically unknown in Canada.

The concentration of nicotinic acid in foods has not been determined, but this vitamin is probably present in relatively good concentration in yeast, wheat germ, liver, milk and eggs.

Vitamin C, or ascorbic acid.—A lack of vitamin C results in the development of scurvy. The most prominent pathological change which occurs in the body is an increased permeability of the capillaries so that there is a tendency to bleeding. The disease is rarely seen under 6 months of age, even in those children who do not receive any anti-scorbutic. The first symptom of scurvy is pain or tenderness of the legs when the infant is handled. This is due to hæmorrhage which has occurred underneath the periosteum at the ends of the long bones. The pain may be so great, with resultant lack of movement, that a mistaken diagnosis of paralysis of the legs may be made. Also the diagnosis of scurvy is sometimes confused with that of septic arthritis. If any of the teeth are through, hæmorrhages frequently occur at the junction of the teeth and gums. Also blood may be found in the urine, stools, skin and mucous membranes.

The vitamin C content of cow's milk is so low that it cannot be depended upon as a source. Accordingly, every artificially fed infant should receive vitamin C in the form of either orange juice or strained factory canned tomatoes. It was formerly thought that as scurvy rarely developed under 6 months of age it was not necessary to administer vitamin C until about 3 months of age, but estimations of the vitamin C content of the blood of young infants indicate that it is advisable to start orange juice or strained canned tomatoes during the first month of life. The amount should be rapidly increased to 1 ounce of orange juice daily or 2 to 3 ounces of strained canned tomatoes. This should be continued throughout childhood.

Vitamin D.—A lack of the sunshine vitamin D results in the development of rickets. In observations undertaken in Toronto it was found that 50 per cent of infants who did not receive vitamin

D during the winter months developed some evidence of this disease, approximately one-half of these in a severe form. Enlarged abdomen, softness of the bones of the skull, delayed closure of the fontanelles, delayed dentition, loss of muscular tone, and deformity of the long bones and ribs are too well known to require any detailed description. As rickets starts at an early age, that is, in the second and third month of life, it is advisable to give every infant, breast-fed or otherwise, some vitamin D, beginning at 2 to 3 weeks of age.

There are available at the present time numerous biologically tested cod liver oils, high potency fish oils, and viosterol. The dose of vitamin D required is approximately 500 international units daily, which are furnished by 1 teaspoonful of most of the cod liver oils available in Canada, or by 3 to 5 drops of the high potency fish oils, such as those obtained from the percomorphum group. Three to 5 drops daily of viosterol are also sufficient.

The administration of vitamin D should be continued throughout the year, with the exception of the two to three summer months when the infant can be out-of-doors and his whole body exposed to the sun's rays. It should be kept in mind that the need for vitamin D does not stop at the end of infancy but continues throughout the whole of childhood.

Vitamin E.—The importance of vitamin E in the nutrition of the child has not been demonstrated. However, vitamin E is widely distributed in many foods, so it is quite unlikely that children do not receive an adequate supply of this vitamin.

One should keep in mind that a lack of any one of the abov mentioned vitamins does not necessarily result in the developmen of a well marked disease. It has been shown that if the optimum amount of these vitamins is not being consumed resistance t disease is definitely lowered. It is therefore essential to see tha children receive adequate amounts of the recognized vitamins This can be accomplished if the child consumes each day a pint t a pint and a half of milk, one egg, two vegetables besides potat (cooked with as little water as possible) and some raw fruit o raw vegetables. In addition, except during the three summe months, some source of vitamin D should be administered daily.

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CALCIUM REQUIREMENTS OF THE NORMAL INDIVIDUAL*

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VII.

Approximately 98 per cent of the calcium of the body is contained in the bones, where, combined chiefly with phosphate and to a lesser extent with carbonate, it gives strength and rigidity to the skeleton. Bone is a living tissue which is most susceptible to nutritional disturbances during the earlier periods of growth. Even in adult life, however, an inadequate supply of the necessary building stones over a long period of time may lead to osteoporosis, with resulting weakness and deformities affecting chiefly the spine. Throughout life the trabeculæ of the bones serve as a storehouse for calcium, giving it up readily on demand and storing it when the supply is great. The storage of calcium as well as the growth of bone may be affected by numerous conditions, infections, metabolic, endocrine and some digestive disorders as well as by faulty nutrition.

Blood serum contains 9 to 11 milligrams of calcium per 100 cubic centimetres and tissue fluids a smaller amount; no calcium is to be found in the red blood cells. These small amounts of calcium are essential for such functions as the maintenance of normal irritability of nervous tissue and muscle, the clotting of blood, and, possibly, the control of permeability of membranes. Great as is the physiological importance of the calcium of blood and soft tissues it requires no special consideration in the discussion of diet, for if the latter be adequate for the growth and maintenance of bone, including teeth, it will be sufficient for these purposes.

The nutritional problem is to ensure a supply of the building materials, calcium and phosphorus, and to provide sufficient vitamin D which is essential for their construction into normal bone and teeth. When the supply of vitamin D is inadequate in early life these structures become faulty. Rickets and caries are then likely to develop and the serum levels of calcium and phosphorus are sometimes disturbed, with resulting tetany. Furthermore, absorption of calcium from the intestines becomes less efficient. The ingestion of an adequate amount of vitamin D or its production by exposure of the body to sunshine or skyshine largely corrects these pathological states, increases the absorption of calcium from the gastro-intestinal tract, renders ordinary variation in the proportion of calcium and phosphorus in the diet of no significance, and leads to active calcification of the bones.

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It is universally recognized that vitamin D is essential for development and growth of bone tissue but its importance in adult life is less easily demonstrated and has often been minimized. That a certain amount is essential may be shown by the fact that adult rickets (osteomalacia), with or without tetany, does occur in women on deficient diets, most frequently during pregnancy and lactation. Ingestion of vitamin D plays an important part in the prevention and cure of this condition.

Two other factors exert some influence on calcium metabolism, namely, the potential acidity and the quantity of roughage in the diet. Neither one is comparable in importance to vitamin D and both may be entirely disregarded when the supply of calcium and vitamin D is abundant. An increased acidity in the gastro-intestinal tract favours absorption of calcium but an increase in the acid elements that must be excreted by the kidney leads to a greater loss of calcium in the urine. In a well balanced diet the potentially acid foods (meats of all kinds, rice, flour, bread) are balanced adequately by the foods with alkaline ash (vegetables and fruits, and to a lesser extent, milk). From the practical point of view the acid-base balance of the normal diet is of little significance. An increase in the residual bulk of the diet interferes to some extent with the absorption of calcium and therefore minimizes the value of the calcium content of leafy vegetables.

It is impossible to state the minimal safe requirement of calcium for any individual at any particular time. The optimal intake varies with the needs for growth and with the supply of vitamin D. A diet that gives a strongly positive balance at one time may give little retention of calcium at another. The important thing is to supply enough calcium, phosphorus and vitamin D to ensure normal growth, development and maintenance of bony structures at all periods of life. The normal development of bone structure of the fetus is dependent on the ingestion of the necessary factors by the mother during pregnancy. The maternal diet is likewise important for the wellbeing of the nursing child. After lactation, the nutritional state depends on the food actually taken by the growing child, adolescent and adult. Whenever the protein of the diet is adequate there will be a sufficient supply of phosphorus. Calcium and vitamin D, however, are more apt to be taken in sufficient amounts. An adequate supply of calcium can be obtained easily by ingestion of milk. The only common food containing appreciable quantities of vitamin D, is egg yolk. This food may supply the small amount needed by the adult but would never be eaten in sufficient quantity to provide the requirements of the period of active growth. It is important, therefore, that vitamin D as cod liver oil or its equivalent be added to the diet of pregnant and lactating women and of growing infants and children, especially when it is not practical to depend on its production by radiation of the body with skyshine or sunshine.

During pregnancy and lactation and throughout the period of growth from 1 to 1.5 grams of calcium should be taken daily in the diet. A glance at Table I will show that this amount is easily supplied by the ingestion of milk and milk products and in no other way. An imperial quart of whole milk (40 ounces) contains 1.5 grams of calcium and when taken daily will provide sufficient calcium for any period of life. The pregnant or lactating woman should take approximately this amount. Should she be overweight she may take one quart of buttermilk, which with half the calories will supply almost as much calcium (1.3 grams). She should be given 2 drachms of cod liver oil or 10 minims of viosterol daily.

The calcium requirement of infants is assured because milk forms the basis of the infant's diet. From infancy to maturity the body must retain on the average approximately 100 milligrams of calcium per day and at some periods much more than this amount. Throughout childhood the diet should contain at least 1 gram of calcium per day. One and a half pints (30 ounces) of milk will provide this amount. Infants and growing children should be given 1 or 2 drachms of cod liver oil or 5 to 10 minims of viosterol or oleum percomorphum every day from the first of October to the end of May.

An adult's diet should contain 0.6 grams of calcium per day. His smaller requirement of vitamin D may be met by the ingestion of one egg daily in addition to the variable amount produced by radiation of the exposed skin to sunshine or skyshine. Adults leading an indoor life might well be given 5 minims of viosterol daily (or its vitamin D equivalent) during the winter months.

There is no danger of giving too much calcium, for the excess will not be retained after the storehouse in the trabeculæ is well filled. Similarly, the amount of vitamin D to be derived from the diet, from ordinary doses of cod liver oil, oleum percomorphum or viosterol, or from exposure of the body to sky and sun will never be excessive. It is only too likely, however, that the supply may be insufficient, especially in cold climates during the winter season.

Should the patient refuse to take milk, considerable quantities of calcium may be obtained by the ingestion of milk products. One ounce of yellow cheese contains about 300 milligrams of calcium, one ounce of cream, 30 to 40 milligrams. The addition of eggs and oranges supplies a small amount: two eggs contain 60 to 70 milligrams and two oranges approximately 100 milligrams of calcium. Ingestion of such foods would fail to supply the calcium needed for pregnancy, lactation and childhood growth but might bring the calcium requirement of the adult to a satisfactory level.

On further observation of Table I it will be seen that the calcium content of meat, most fruits, root vegetables, cereal grains, flour and bread is too low to provide significant amounts. At first glance one might consider cauliflower and the greens a valuable source. On examining Table II, however, one realizes that excessive bulk of these foods would be required to provide an adequate amount of calcium, and, furthermore, the assimilation of

TABLE I.

CALCIUM CONTENT OF COMMON FOODS PER 100 GRAMS (3 OUNCES)

	Calcium gm.
Milk foods:	
Whole milk	0.130
Buttermilk	0.110
Cream 15 to 30 per cent	0.090 to 0.100
Cheese (yellow)	0.930
Butter	0.015
Eggs (2 hen's eggs)	0.067
Meats, fish, fowl	0.010 to 0.020
Fruits:	
Oranges, raspberries and rhubarb	0.040 to 0.050
Dates, prunes, raisins	0.050 to 0.060
Most other fruits	0.010 to 0.020
Vegetables:	
Asparagus, beets, Brussels sprouts, potatoes, sweet potatoes, sweet corn, green peas	0.010 to 0.025
Cabbage, lettuce, celery, spinach, green beans, carrots, parsnips	0.040 to 0.070
Cauliflower, chard leaves, dandelion greens, watercress	0.100 to 0.120
Cereals:	
Flour, bread, crackers, rice, tapioca, etc	0.010 to 0.025

TABLE II.

AMOUNT OF DIFFERENT FOODS REQUIRED TO SUPPLY 1 GRAM OF CALCIUM

Food	*Amount*
Milk	1½ pt.
Cheese	3½ oz.
Chard	1½ lb.
Cauliflower	2 lb.
Celery	3 lb.
Spinach	3 lb.
Cabbage	5 lb.
Lettuce	5 lb.
Oatmeal	3 lb.
Bread	8 lb.
Beef	17 lb.

calcium would probably be less complete because of the large residue. If the patient cannot or will not take sufficient milk products, inorganic salts of calcium may be administered. One gram of calcium may be given in 42 grains of B.P. calcium chloride,* in 118 grains of calcium lactate, or in 160 grains of calcium gluconate.

SUMMARY

In normal nutrition, calcium, phosphorus and vitamin D are inseparably associated. Of these vitamin D chiefly, and calcium to a lesser extent, are likely to be supplied in insufficient quantities. Throughout the whole growth period vitamin D should be added to the diet. Calcium can be obtained in sufficient amounts only by the ingestion of milk and milk products.

Pregnant and lactating women should be given 2 drachms of cod liver oil or 10 minims of viosterol or oleum percomorphum while taking approximately 1.5 grams of calcium (40 ounces of milk) in the diet daily. Infants and growing children should receive 1 to 2 drachms of cod liver oil or its vitamin D equivalent daily during the eight winter months. Growing children should take at least 30 ounces of milk every day, thus ensuring an intake of 1 gram of calcium. The adult should take at least 0.6 grams of calcium, the addition of small doses of vitamin D sometimes being desirable.

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*Since calcium chloride as dispensed commonly contains a variable amount of water of crystallization, not present in B.P. calcium chloride, as much as 75 grains may be required to provide 1 gram of calcium.

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THE PLACE OF BREAD IN THE NORMAL DIET*

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VIII.

> "Except in arctic climates, bread and cereals are always important items in the food of mankind, and except where wealth has accumulated and luxury comes in its train they are by far the most important. Circumstances have to be very exceptional indeed when the growing of cereals does not yield an *energy* supply for the worker at less cost and with less relative effort than any other method of food production."

Thus wrote Sir F. G. Hopkins[1] in 1917, at a time when the world was counting its food supply more closely and scientifically than ever before. In nearly every part of the world some form of breadstuff, or food made from grain, is found to be the largest contributor to the energy of the food supply, and in that sense the staff of life. In the West reliance has been placed on wheat, but in the world as a whole rice far surpasses wheat in the contribution which it makes to the feeding of the human race. In the United States wheat flour is estimated to furnish more than one-fourth of the total calories of the diet.

TABLE I.

Foodstuffs	*Percentage distribution*					
	Cost	*Calories*	*Protein*	*Phosphorus*	*Calcium*	*Iron*
Meat and fish	32	19	35	26	4	30
Milk and cheese	11	8	12	21	56	6
Grain products	18	38	37	30	16	26
Vegetables	11	9	10	16	15	26

The contribution made by grain products to our dietary will be seen in Table I, which is based on statistics of the U.S. Department of Agrictulture for 224 families.[2] It expresses on a percentage basis, relative to cost, the amounts of important elements contributed by the main foodstuffs to the food consumed.

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The same importance of wheat products in England and Scotland has been shown by Cathcart and Murray[3] in a recent report of the Medical Research Council of Great Britain. They have analyzed the food consumption of 259 families of St. Andrews, Cardiff and Reading, and expressed their results on the basis of the food eaten per week by an adult man. Their results for St. Andrews are shown in Table II and this again illustrates the dietary importance of breadstuffs. The latter contribute 31 per cent of the protein, 8 per cent of the fat, and 43 per cent of the carbohydrate in these diets. From Starling's figures[4] wheat accounts for one-third of the total calories in the English dietary.

TABLE II.

CONSUMPTION OF FOODSTUFFS BY 149 FAMILIES OF ST. ANDREWS, SCOTLAND

Foodstuffs	*Food per man weekly*			
	Quantity	*Protein*	*Fat*	*Carbohydrate*
		gms.	*gms.*	*gms.*
Meat	2.04 lbs.	129	340	29
Fish and game	0.49 "	34	7	1
Milk	4.68 pts.	80	80	119
Dairy produce	1.42 lbs.	52	263	9
Bread	5.40 "	174	60	1,214
Cereals	1.13 "	59	15	370
Sugar	1.74 "	2	5	702
Vegetables	3.48 "	28	10	270
Fruit	1.54 "	5	2	80

The amount of bread and wheat products eaten by these families varied from 4 to 8 lbs. per man weekly. "The level of consumption of brown bread might almost be regarded as an index of social standing" (Cathcart and Murray, p. 13), in that 100 per cent of professional families ate it, 55 per cent of shopkeepers, 39 per cent of skilled workers, and 14 per cent of unskilled workers and the unemployed. White bread was eaten by all, but to the greatest extent by families of the unskilled workers.

In a consideration of restricted and minimal adequate diets in the United States Stiebeling and Ward[5] have stated that grain products, especially if unmilled and supplemented by milk, are inexpensive sources of energy, protein, phosphorus and iron. Milk is an inexpensive source of calcium, phosphorus, high quality protein, and vitamins A and B_2, supplying cheaply what the grains lack—hence the dietetic importance of the cereal-milk combination in the low-cost but adequate diets.

The wheat grain may be considered to consist of four parts, the outer covering or bran, the inner aleurone layer, the endosperm or starch cells, and the germ or embryo. Of these bran forms about 5 per cent of the wheat kernel; the aleurone layer, 8; the germ, 5; the endosperm, the remaining 82 per cent. Now, in the modern practice of roller milling various grades of flour are produced containing different percentages of the structural elements of the wheat grain.[6] About 72 per cent of the weight of cleaned wheat is obtained as white flour and the remainder is sold for stock feeding as bran or "shorts". In the process of sieving middle fractions are obtained consisting of parts of the endosperm relatively rich in protein and more difficult to pulverize, which are called "middlings". Ordinary patent flour is thus a blend of soft, white flour and middlings, frequently from different types of wheat. From a nutritional standpoint these different parts of the grain have very different values,[7,8] and therefore bread made from different flours will likewise differ appreciably. The situation as accepted at present has been expressed by Klein, Harrow, Pine and Funk[9] as follows, "The various layers of the cereal grains differ not only in their vitamin content and in their content of inorganic salts but also in their general protein make-up. The fractions known to contain the bulk of the vitamins contain also proteins of high biological value.

"The fractions which contain the pericarp and the germ and which serve as the main ingredient of the dietetically superior whole grain flour possess a much higher nutritive value for rats than fractions which are composed mainly of the endosperm."

Whole-wheat flour and middlings have been shown to be an excellent source of vitamins B_1 and B_2,[10,11] unaffected by baking.[12] The wheat embryo is a fair source of iron and copper, well utilized in the formation of hæmoglobin.[13,14] The proteins of the pericarp and embryo are of good biological value comparable with those of meat,[15,16,17,18] and inferior only to those of milk and eggs. With the exception of the cellulose or "crude fibre" the carbohydrates and proteins of bread are readily digested and absorbed to the extent of 97 and 87 per cent respectively on an exclusive bread diet. The crude fibre, especially of whole wheat or Graham breads, causes laxation,[19,20,21] making the fæcal mass more bulky, softer, higher in water content, and in some cases increasing the frequency of defæcation.

The controversy of white versus whole-wheat bread has subsided. Investigators in this field are almost unanimous in stressing the superiority of whole wheat. The term is however a misnomer because ordinary patent white flour is about a 73 per cent extraction from the whole grain; whole-wheat flour, 82 per cent, and Graham flour, 100 per cent.[22,23] The superiority of the whole-wheat flour rests in the higher content of vitamins, minerals salts, and proteins and in its laxative action. It should, however, be noted that the use of whole-wheat bread exclusively is neither necessary nor advisable for all people without exception. The laxative action in certain individuals, especially children, may be excessive and indeed harmful, and this is generally true for all forms of enteric disease.

It is not suggested that bread alone is a *perfect* food, but it is an *important* food, and, supplemented by milk, it provides an economical, nutritionally sound basis for our national dietary.

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THE IRON REQUIREMENT IN NORMAL NUTRITION*

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IX.

Introduction

The total amount of iron in the human being is small—about 400 mg. at birth and somewhat less than ten times this amount in the adult—but it plays a very important part in the functions of the body. As a characteristic constituent of hæmoglobin it is necessary for the transport of oxygen in the blood, and as an essential component of cytochrome and other hæmo compounds it plays an important rôle in intracellular oxidations and tissue metabolism. Iron, therefore, is an essential constituent of all living tissues.

Most of this metal is contained in the circulating hæmoglobin, and, although a portion of this is being constantly destroyed and partly excreted as bile pigment, the iron fraction is retained to a very large degree. This retained iron is used over and over again by the bone marrow to make new hæmoglobin to replace that destroyed, but if any iron is lost from the body, as from menstruation, pregnancy, lactation, or pathological hæmorrhage, or if it is necessary to increase the total amount of circulating hæmoglobin, as in the case of the growing infant, then additional iron must be supplied from other sources.

If the stores of iron that are available for these needs become depleted, as will occur if insufficient iron is absorbed from the diet, a state of anæmia will occur. It is therefore important to consider the need for additional iron in these conditions and how this need may be met most adequately.

Iron Requirement

1. *In infancy and childhood.*—During the period of active physical growth there is an increase in the total amount of hæmoglobin co-incident with the increase in size and blood volume. During the first year the amount of iron which must be utilized for this purpose is about 200 mg. In the normal infant the stores of iron present at birth will supply the amount necessary for the

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first six months; thereafter the additional iron must be derived from the food. If the stores of iron are deficient, as they may be in infants born of mothers anæmic because of iron deficiency, or if the relative rate of growth is very rapid, as it may be in premature infants, the reserve of iron present at birth will become depleted more quickly than normal and additional iron must be derived from external sources at an earlier age than in the case of the normal child. In older children the retention of iron necessary

TABLE I.

APPROXIMATE IRON CONTENT OF FOODS RELATIVELY RICH IN IRON

Food	*Iron content*
	mg. percentage
(*a*) *Vegetable*	
Almonds	4.0
Apricots, dried	6 - 7
Barley, entire	4 - 5
Beans, kidney, dried	7 - 10
" Lima, dried	9 - 12
" Lima, fresh	2 - 3
Beet greens	3 - 4
Brazil nuts	4.0
Broccoli leaves	2 - 3
Chard	3 - 4
Dandelion greens	2 - 6
Dates	4 - 5
Figs	2 - 4
Kale	2 - 3
Oatmeal	4 - 5
Mustard greens	3.0
Peaches, dried	6.0
Peas, dried	6.0
" fresh	2.0
Prunes	2 - 5
Raisins, seeded	3 - 7
" seedless	3 - 4
Spinach	3 - 6
Turnip tops	3 - 4
Watercress	1 - 7
(*b*) *Animal*	
Bacon	1 - 2
Beef, lean	3 - 5
Egg yolk	8.0
Ham	4.0
Lamb chops	3.0
Liver, beef	6 - 8
" calf	5 - 13
" lamb	3.0
" pork	20 - 25
Kidney, ox	5.0
" pig	9.5
Mutton	5.0
Oysters	3 - 6

to meet the demands of growth for the first ten years is approximately 100 to 200 mg. a year. At puberty the demand for iron is almost doubled because of the rapid growth which occurs at that time in both sexes and, in addition, in girls because of the onset of menstruation.

2. *In adults.*—In the adult the need for absorption of iron from food is determined by the amount lost, either in the excreta or by pregnancy, lactation, or by pathological hæmorrhage. As almost no iron is lost in the urine, and as the amount lost by bowel is very small, the iron requirement of the adult male who is not bleeding will be very low. In woman, however, the amount of iron lost in the normal menstrual flow amounts to 15 to 25 mg. every month, or 200 to 300 mg. a year, and if menstruation is prolonged or excessive much greater losses may occur.

3. *During pregnancy.*—It has been estimated that during a pregnancy the additional iron necessary to meet the demands of the maternal and fetal organisms is approximately 600 mg. If inadequate iron is supplied to the mother during this period the maternal reserves of iron will become depleted and the mother may become mildly or severely anæmic. The baby born to such an anæmic mother has at birth a normal complement of hæmoglobin but an inadequate reserve of iron, so that early in life it too may show a similar anæmia unless supplied with an abundance of food or medicinal iron.

IRON IN THE DIET

Although it is possible to estimate the amount of new iron which must be utilized to meet the demands of growth and to make up the physiological losses, it is not an easy matter to state exactly how much food iron must be eaten to assure the absorption of this amount.

The iron content of most of the common foodstuffs has been frequently determined. In spite of wide variations in the values found it is possible to make certain generalizations. Milk, both cow's and human, although a perfect food in almost all other respects, contains very little iron—probably not more than 0.05 to 0.1 mg. per 100 c.c. The iron content of all the fruits and vegetables in the fresh state is low, with the exception of peas, beans and the green leaves of plants. Naturally, the iron content becomes increased when the fruits are dried; this accounts for the relatively high iron content of such dried fruits as apricots, peaches, currants, figs, dates and raisins. Even though the iron content of the dried fruit is relatively higher the amount of an average serving after it has been prepared for eating will be the same as that of the fresh fruit and the actual amount of iron consumed will be small. Green, leafy plants, and the green portions of plants contain much more iron than the pale, colourless parts. Highly purified cereals, such as polished rice and white flour, contain much less iron than the unmilled grains because most of the iron in these foods is contained in their outer coverings. The most abundant sources of iron in our diet are the various animal foodstuffs including eggs, but excluding milk, cheese, butter and fish. The iron content of certain edible viscera, such as heart, kidney and liver is particularly high, and even though only a portion of the total iron in liver is "available" (48 to 80 per cent, according to different observers) this is probably the richest source of iron that could be included in our dietary.

However, only a portion of the iron taken in with food is utilized and the greater part of it is excreted largely unchanged in the stool. This occurs partly because certain forms of iron, such as that bound organically in the form of hæmatin, cannot be utilized at all, and partly because the iron that could be utilized is only partially absorbed. About all that can be said is that, in order that a given amount of iron be absorbed into the body and used for the purpose of building new hæmoglobin and for other specific body needs, a large excess of food iron must be eaten. Balance experiments have indicated that in the growing infant a food iron intake of 0.5 to 1.0 mg. per kilo of body weight is necessary, after the utilization of their own reserves, to assure the retention of new iron so necessary for their growth. As milk is so poor in iron, some better source of iron should be fed as early as possible, certainly by the beginning of the sixth month and probably earlier in premature babies or in babies born of anæmic mothers. There are various foods which can readily be admitted to the infant's dietary which will supply a sufficiency of iron. Egg yolk and sometimes a specially prepared purée of vegetables may be added at the age of six months, and scraped beef and small amounts of liver can generally be tolerated towards the end of the first year. Certain prepared infants' foods, such as Pablum, have inorganic iron added to supplement the natural food iron of the product. If there is any anæmia inorganic iron, such as iron and ammonium citrate, can be added in small amounts directly to the infant's formula.

The requirement of older children will probably be met by a daily intake of food iron of 0.5 mg. or less per kilo. In adults the iron intake necessary will be determined by the amount of iron lost from the body by physiological or pathological means. Experimental data have shown that adult men have been kept on iron equilibrium for long periods on an intake of 5 mg. of iron daily. Several observations on women with normal menstrual flow have indicated that a balance has been maintained on a daily intake of 10 to 15 mg. of iron. In pregnancy an intake of 20 mg. daily has been suggested as the minimal amount necessary to meet the extra demands accompanying this state, although adequate retention has been observed when the intake was definitely less than this amount. Such intakes are readily assured provided that the diet is reasonably well balanced and contains an average amount of such iron-containing foods, as meat, eggs and green vegetables.

Studies on the dietaries of the population of several countries have indicated that, from the point of view of iron content, the average diet is generally adequate. In the United States values from 12 mg. per day in the cheaper diets up to 20 mg. in the more expensive ones have been found. In Scotland, among the poorer classes, averages of 11 mg. of iron daily have been found, and

TABLE II.

APPROXIMATE IRON CONTENT OF SERVING PORTIONS OF VARIOUS FOODS

Food	*Weight per portion*	*Iron per portion*
(*a*) *Vegetable*	g.	mg.
Almonds	15	0.6
Apples	100	0.4
Apricots, dried	25	1.5
Beans, kidney	50	4.0
" Lima	50	5.0
" string	70	0.6
Beet greens	100	3.0
Broccoli	100	2.0
Bread, rye	25	0.5
" white	25	0.2
Cabbage	40	0.2
Chard	100	3.0
Dates	45	1.5
Figs, dried	50	1.5
Lettuce head	50	0.2
Oatmeal	25	1.0
Orange E. P.	200	1.0
Peaches, dried	25	1.5
Peas, green	100	2.0
" split	50	3.0
Prunes E. P.	33	1.5
Raisins	30	1.5
Spinach	100	4.0
Tomatoes	100	0.5
Watercress	50	2.5
Wheat bran	40	3.0
(*b*) *Animal*		
Bacon	25	0.5
Beef, Lean	100	4.0
" liver	100	7.0
" kidney	75	3.5
" heart	75	4.0
Calf liver	100	8.0
Chicken	120	2.0
Duck	120	2.0
Egg	50	1.0
Fish	100	0.7
Lamb chops	100	3.0
Lamb liver	100	3.0
Milk	250	0.3
Mutton	100	5.0
Oysters	100	3.0
Pork chops	60	1.0
Pork liver	100	20.0

many persons were observed to be in good health on intakes as low as 6, 7 and 8 mg. daily. A recent English investigation has shown that the iron intake of a number of persons in whom there were no dietary restrictions from lack of income or other cause averaged 16.8 mg. for males and 11.4 mg. for females. Intakes such as these would probably meet all normal requirements.

From what has been said about the extent of the demands for iron it would seem that a state of iron deficiency arising from inadequate iron in the diet would only occur under conditions where the demand was greatest. This is probably true, and perhaps the largest number of mild iron deficiency states occur in rapidly growing infants, in pregnant women, and in women suffering from menorrhagia. A similar condition may occur in certain women who have achlorhydria and in adult men only under conditions of excessive blood loss by pathological hæmorrhage. Even in these cases such a condition arises only with considerable exhaustion of the iron reserves.

If anæmia of this kind has occurred, the fact that only a small amount of iron can be absorbed from food makes it impossible to alleviate the condition satisfactorily by the use of foods containing even high amounts of iron. In an adult the amount of iron necessary to cause an increase of 1 per cent in the hæmoglobin content of the blood is about 25 mg. Many days might be required to obtain this much iron from the food alone. By addition to the diet of relatively large amount of inorganic iron salts it is possible, however, to cause the utilization of this much iron in the course of a single day, and any anæmia due to iron lack can be quickly abolished.

SUMMARY

Iron is an essential constituent of hæmoglobin and of all living tissues.

Iron must be obtained from food to meet the demands of growth, pregnancy, physiological or pathological hæmorrhage, and to replace the stores of iron if these become depleted. The periods of life during which it is very important to make certain of an adequate intake of iron are those of growth and pregnancy.

The most abundant sources of iron in our diet are the flesh and edible organs of mammals. Certain vegetables, such as peas, beans and green portions of plants, contain appreciable quantities of iron. Egg yolk is also a valuable source of this substance.

The milk diet of the growing infant should be supplemented as soon as possible by the addition of egg yolk, liver, scraped beef, green leafy vegetables and other iron-containing foods, and in some cases by the addition of small amounts of inorganic iron.

Inclusion in the daily adult diet of one or two average servings of meat or eggs and liberal quantities of green vegetables will almost certainly assure an intake of iron adequate to meet all normal needs.

INTRODUCTION OF SOLID FOODS INTO THE DIETS OF CHILDREN*

BY T. G. H. DRAKE

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X.

Milk alone, either human or cow's, is nutritionally adequate only for the first month of life, after which the rickets- and scurvy-preventing vitamins must be added in the form of fish liver oils and citrous or tomato juices. To prevent the development of other vitamin and mineral deficiency diseases not controlled by these supplements, especially nutritional anæmia, and to accustom the infant gradually to the adult type of diet solid foods must be added to the fluid diet. While the use of thick feedings in the treatment of pylorospasm has shown that cereal feedings may be tolerated as early as 1 month of age, the conservative practice of starting solid foods at 3 to 5 months of age is best. Earlier introduction of solid foods into the milk diet may render the infant sensitive to their proteins, and many clinicians believe that the premature introduction of solids is the cause of many of the digestive upsets encountered in later infancy and childhood.

In introducing solid foods into the diet the regular feeding intervals should not be altered. New foods should be offered one at a time. A small amount (approximately 1 teaspoonful) should be offered at the beginning of one of the feedings on the first day, and the amount gradually increased. With the first solid food, remember that the infant must become accustomed not only to the taste but also to the swallowing movements necessary, since it cannot obtain the solid spoon-fed material by the sucking movements to which it has previously been accustomed. Persistent refusal to take the food is rarely encountered when the new material is introduced at the proper age, but should this occur the meal should be removed at the end of 20 minutes without offering the milk-feeding which the infant likes, and he should be allowed to go until the next regular feeding period, being offered nothing but boiled water in the interval. Force and bribery should not be resorted to, and comments from the audience are barred, since even at this early age the infant usually enjoys the struggle and attention which is too frequently created by his refusal to take the food offered.

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Cereals.—In the selection of the cereal, the infant's first solid food, the following points must be considered. The cereal as fed should be thoroughly cooked and of porridgy, not gruel-like, consistency. It should not be excessively laxative, and in addition to supplying calories it should contain in liberal amounts the protective minerals and vitamins. These requirements are best met by the use of a cereal mixture* containing wheat, oat and corn meals, to which have been added for their mineral and vitamin content wheat germ, brewer's yeast, machine-dried alfalfa and edible bone meal. "White" cereals, such as farina, consist essentially of the white flour portion of the grain, and, while non-laxative, contain only minute amounts of vitamins and minerals. Whole grain brown cereals, while higher in minerals and vitamins than the white cereals, may be irritating to the infant's bowel on account of the bran content.

Cereals for infants should be cooked for 1 to 4 hours in a double boiler, in the proportion of ½ cup of cereal to 1½ to 2 cups of water. The water is measured into the upper portion of the double boiler, a pinch of salt added, and the water brought to the boil over the direct flame. The cereal is added slowly with constant stirring to prevent lumping and cooking continued until thickened (3 to 5 minutes). The upper portion of the double boiler is then placed over the lower part, which should be about one-third full of hot water, and the cooking is continued for 1 to 4 hours. To prepare pablum for infant feeding the required amount of the dry pre-cooked cereal is poured into a cereal dish and stirred with a fork while the water or milk and water formula is added until of a porridge-like consistency. *In vitro* and *in vivo* experiments have shown that this cereal is more digestible than ordinary cereals which have been cooked for 4 hours.

At 3 to 5 months of age cereals should be started at the beginning of the 10 a.m. and 6 p.m. feedings, and the amount fed gradually increased until the infant is taking 2 to 4 tablespoonfuls of the cereal as prepared for consumption at each of these two feedings.

Bread.—After the baby's first tooth has erupted he may be given bread dried in the oven, or zwieback or sunwheat biscuits.

Eggs.—Egg yolk should be added to the diet at the 2 o'clock feeding from the sixth month on. On account of the possibility of an allergic reaction manifesting itself, such as a skin rash or digestive upset, egg yolk should be started in small amounts, one-quarter teaspoonful or less, and gradually increased to a whole egg yolk. Eggs may be soft-boiled, hard boiled and mashed, or coddled. From 1 year on the whole egg may be served, either cooked alone, in custards, or in other food.

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*One such preparation is available under the trade name Mead's Cereal, or n its precooked form "Pablum".

Vegetables.—The actual energy value, or caloric value, of vegetables is comparatively low; they belong to the protective as distinguished from the energy-producing foods on account of their more abundant mineral and vitamin content. They are especially valuable for the prevention of nutritional anæmia. Green and root vegetables may be included in the diet at the 2 p.m. feeding from the 8th month. To accustom the infant to the different tastes, they should be served separately rather than in mixtures. Selections may be made from carrots, chard, green peas, green lima beans, fresh asparagus, string beans, young beet greens, and cooked lettuce. Spinach should not be served to the exclusion of other greens, to most of which it is inferior nutritionally. When 1 year old the child may also have squash, celery, beets, cauliflower and kale. To reduce loss of minerals and vitamins in discarded cooking water, vegetables should be cooked in the least amount of water possible. The cooking water should be served with the vegetable or used in vegetable and meat soups. The amount of water remaining on green leafy vegetables (with the exception of cabbage) after washing is sufficient for cooking. Green leafy vegetables should be cooked in a saucepan until soft, from 10 to 15 minutes, with frequent stirring to prevent burning. In a double boiler from 30 to 45 minutes usually suffices to cook soft root and stalk vegetables which have been chopped fine. The soft cooked vegetables and greens are put through a sieve or strainer. Canned sieved vegetables are obtainable today, many of which are the equal or superior of the home-prepared article. Baked potato is also valuable, but must not take the place of other vegetables. At the end of the second year sieving is no longer necessary, simple mashing of vegetables being sufficient.

Fruits.—Apple sauce or apricot or prune pulp may be given for supper, beginning with the 10th month. Prunes or dried apricots should be soaked over night and cooked until soft enough to mash through a strainer. Banana when well ripened (shown by the skin presenting brown patches) may be served raw after thorough mashing with a fork. After the first year baked apples, stewed pears and peaches, and scraped raw apple may be included in the diet.

Meat and fish.—Scraped beef may be added in the latter part of the first year. This is prepared by scraping lean round steak across the grain with a dull knife or sharp spoon. The meat thus obtained is made into a patty and lightly cooked under the broiler on both sides, or in the top part of a double boiler over hot water. Later, boiled, broiled or roasted and finely divided beef, lamb, chicken or liver may be used. Steamed, baked or boiled and carefully boned non-oily fresh fish, such as cod, haddock or halibut, may be fed once or twice weekly.

Prohibited foods.—The following foods should not be given to young children: greasy and highly seasoned foods; fried foods of all kinds (except crisp bacon); fresh bread and bread-stuffs; pies, cakes and fancy cookies; ice-cream; pork or veal; corn or cucumbers. Coffee and tea should be forbidden, partly on account of their caffeine content but largely because they replace milk. Nuts are hard to digest, and there is risk that they may be aspirated. The consumption of candies will decrease the appetite for the necessary mineral- and vitamin-containing foods. The child may have the amount of sugar commonly employed in cooking, but sugar should not be used on cereals and fresh fruits. It should always be remembered that a child will not cry for a food which it has never tasted.

A diet suitable for the 12 to 15 months old baby is appended.

7 to 8 a.m.

1. 2 to 4 rounded tablespoonfuls of cooked cereal or prepared pablum, with 2 to 3 ounces of boiled milk over it; no sugar.
2. 6 to 8 ounces of boiled milk.
3. 1 piece of zwieback or toast, or 1 to 2 sunwheat biscuits; no butter.

9 a.m.

2 ounces of orange juice diluted with an equal amount of water; or twice this amount of the liquid obtained by mashing factory-canned tomatoes through a sieve.

12 to 1 p.m.

1. 1 egg, or ½ to 1 rounded tablespoonful of scraped beef, or finely divided calf's, beef or lamb liver, or minced chicken.
2. 3 to 4 tablespoonfuls of sieved vegetables.
3. 2 to 3 rounded tablespoonfuls of junket or custard, rice, sago, tapioca or cornstarch pudding, with added milk.
4. 1 piece of zwieback or toast or 1 to 2 sunwheat biscuits. No milk to drink with meal; milk is contained in the desserts.

5 to 6 p.m.

Same as at 7 to 8 a.m., with the addition of 1 to 3 rounded tablespoonfuls of prune or apricot pulp, apple sauce or baked apple.

10 to 11 p.m.

8 ounces of boiled milk if hungry, that is, if the child wakens and cries for food.

1 teaspoonful of biologically standardized cod liver oil two or three times daily, or 5 to 10 drops of percomorphum oil or other fish liver oil of high vitamin D concentration, once daily from September to June.

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IODINE IN NORMAL NUTRITION*

BY WALTER R. CAMPBELL

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XI.

Physicians are now accustomed to expect profound physiological effects from infinitely small amounts of substance. One of the first of such substances to be studied was iodine, the discovery of which was perhaps the most useful by-product of the Napoleonic wars. The British blockade of the French coast cut off the supplies of Chilian saltpetre required for the manufacture of gunpowder. Decomposing calcium nitrate with the ashes of kelp as a source of potash, Courtois in 1811 found iodine in the vats. Within the next ten years the sources and principal properties of this new element were described, and Coindet correlated the iodine content of the ashes of sponges and seaweeds with the knowledge existent since ancient times of their favourable influence on goitre. He used the element in the treatment of such cases with happy results in some but with unfavourable results in others. These untoward toxic manifestations prompted him to issue a warning that iodine should only be used in limited doses and under careful medical supervision, a warning which has been insistently repeated and consistently ignored in the last one and a quarter centuries.

Iodine is widely but sparsely distributed in nature; indeed the amount is frequently recorded in parts per billion. Only in the sodium nitrate beds of Chile and Bolivia does it reach a concentration of 0.2 per cent.† There are few minerals in which it is an essential component. All rock contains some iodine, but the element is most abundant in those sedimentary types which contain fossils. In most rock formations the iodine is supposed to be dissolved in the connate water and only gradually leached out. Disintegration of the rock by weathering gives rise to soils of various types. Those of a sandy character retain but little iodine, while the more colloidal types, such as the clays, usually adsorb part of the iodine leached out of the rock. In mountainous regions and recently glaciated areas iodine is scarcer than in other regions, particularly those which have been below sea level. For this reason a considerable part of Canada is low in iodine. While this is particularly well known, from the results on animals and man in the Great Lakes basin and in the mountainous regions of the West, there is little reason to doubt that a similar situation exists in our more northerly regions.

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†For the purposes of this article it has not appeared necessary to quot many exact figures. For these the reader is referred to the literature, excellen summaries being McClendon: Physiological Reviews, 1927, 7; and Orr an Leitch: Special Report No. 123, Medical Research Council, 1929. Thoug many of the older figures have been confirmed repeatedly the methods availabl were not so satisfactory as those of today, and even at the present time relativ order of magnitude is probably more truly representative of the facts than som of the actual figures recorded.

Iodine has a great affinity for organic matter, and plants grown in a particular soil contain more iodine than the soil itself but vary greatly in iodine content from the same species grown elsewhere. Coal and oil likewise contain considerable iodine, probably because of their derivation from living matter. While it is being continually swept toward the sea by rivers and streams the aquatic plants take up a considerable amount of it. The concentration in the sea water itself is not very great, most of the iodine uniting with organic matter. Thus the ash of kelps and other sea plants is high in iodine content while sea fish contain ten to a hundred times as much iodine as fresh water fishes. Salt beds from ancient dried-up seas contain iodine but this is largely lost in the modern processes of purification of the salt.

Since but little iodine is carried landward in water vapour regions more than three miles from the sea benefit but little from the iodine content of the rainfall. As fuels have a relatively large iodine content it is probable that some of it, though largely concentrated in the soot, is discharged into the air of manufacturing communities. It is known that the air of cities contains more iodine than that of non-urban regions, but it has been shown that all of this iodine is removed by filtration of the air so it probably exists combined in organic form.

Small amounts of iodine are present in all foods, the quantity in animal tissues other than sea foods and thyroid being less than that of normal blood—13 γ per 100 c.c. ($1 \gamma = 0.001$ mg.) or 130 parts per billion. The variation is much less than in plant foods whose various species contain differing amounts of iodine even though grown on the same land. The iodine content of milk is small, but may be ten to one hundred times as great in non-goitre areas as in those in which goitre is prevalent. It undergoes seasonal variations probably related to the iodine content of the food being consumed. The thyroid gland contains iodine, as was shown by Baumann, in the highest percentage of all animal tissues. There is some seasonal variation and some evidence that the amount is greater in females than in males. It is also probable that like the blood it varies with the changes in the sexual cycle. It may be much enriched by administering small doses of potassium iodide.

In surveying the effect of iodine in small doses on mammalian metabolism it would seem probable that its effects are largely exerted through its conversion into thyroxin by the thyroid gland. In cases where such conversion does not take place, for example, in the cretin, the effects are absent, while the administration of preparations containing thyroxin exerts the characteristic effect. Thyroxin is a catalyst catalysing all the physiological functions. It is essential for a complete differentiation of the brain and for proper growth of the individual. Overdosage of thyroxin may give rise to characteristic symptoms some of which are not identical with those of iodine overdosage. In the writer's opinion there is little to recommend the view that abnormal thyroxins are a feature of thyroid disease.

The adult human body, Kendall estimates, contains about 20 mg. of iodine, an amount which, from McClendon and Hathaway's data, could be absorbed from the food available in the region in about five years. Perhaps half of this iodine is quite inactive, being in storage in the thyroid. One-third of the remainder is probably present in inorganic form, and, roughly speaking, 10 mg. of thyroxin might be contained in the organic fraction. As Boothby has shown, such an amount is sufficient to raise the metabolism of a myxœdematous individual 28 per cent or, in other words, approximately to the normal level. It deteriorates at the rate of 10 per cent per day. Some apology may be necessary for these rough calculations as well as for the deduction that the normal thyroid reserve of organic iodine compounds is ten times the daily requirement. But this means a release o 600 γ of iodine per day, whereas from the slender data available some 15 γ is the minimum intake for adult iodine equilibrium The "internal circulation" of iodine or the iodine reclaimed from degraded thyroxin must then represent a very considerable part of the metabolic iodine exchange, and emphasizes the necessity for long-period experiments on iodine metabolism.

In view of the many factors entering into the matter th minimal requirement for any substance is by no means the mos suitable amount to provide. At least three times this amount i desirable and since it has been shown that the minimal amount required by children is three times that of the adult one must allow 50 to 150 γ per day as the suitable intake of iodine. In many different regions of the world the impossibility of ingesting sufficient iodine in the foodstuffs available is apparent from the analyses which have been done. This is particularly true of the larger figure which affects children but will likewise be true in adults during the so-called physiological epochs, puberty, the menstrua cycle, pregnancy, lactation, as well as during infection, when a increased requirement for iodine exists. Where such a deficienc exists goitre is prevalent particularly at the pubertal period. Thi is true not only of simple goitre but of the toxic type as well.

The empirical use of substances now known to contain iodine for the cure of thyroid disease goes back at least thirty-five centuries. Thyroid gland, ashes of sponges, or seaweed, and certain mineral spring waters, etc., were known to be valuable. With the isolation of the element itself 127 years ago a great deal of experimental work proved its influence both for good and, in excessive doses, for bad. Though somewhat diminished by the alarming results of overdosage and later overshadowed by the growth of the germ theory of disease its therapeutic use has never wholly died out and in the last quarter century has been revived.

Stimulated by the experiments of Marine and others, a very complete control of the goitre problem has been attained in Switzerland, and much has been done in other countries. While precipitating influences play their part, a fundamental rôle in thyroid disease must be assigned to iodine deficiency and it is apparent that only prolonged deficiency is of practical importance. Satisfactory surveys either of the clinical or the chemical problem in Canada have not been made, but sufficient is known by analogy to justify a nation-wide attack on these problems now being dealt with only in desultory fashion. Due to the distribution of population it is already clear that the great majority of our people are subject to relative iodine deficiency, and it is well known that its effects on the mental and physical state of the inhabitants will become more pronounced in succeeding generations. Various plans have been advocated for provision of the necessary iodine. The use of a fertilizer containing iodine will improve the yield of many crops and the health of man and animals subsisting on that soil, but such a project seems somewhat impractical. Iodization of water supplies has been tried with benefit in certain cities, but neglects the non-urban population. Administration of iodine as a drug is effective but does not reach the whole population, nor is it likely to be used continuously.

It is known that iodine in small doses over long periods of time is more effective than large doses at intervals and lacks the danger of the toxic effects of the larger dose. The most effective solution at present seems to be the addition of small amounts of iodine to salt. This has been done and is now available to families alert to its advantages but fails to reach a great part of our population. To ensure its benefits compulsory iodization of all salt sold for human consumption will be necessary. Where this has been done, as in Switzerland and Austria, the results have been most gratifying.

Some question has arisen whether or not the amount of iodine used in iodizing the salt on this continent, which is ten times the amount used in Switzerland, may not be productive of toxic symptoms, or even initiate definite hyperthyroidism. While it is unfortunately only too frequently that one encounters dangerous or even fatal effects which have been produced by iodine overdosage I have never encountered a case arising from the use of iodized salt alone. It is surely incumbent on anyone publishing such a case to supply more than *post hoc* evidence. When idiosyncrasy to iodine is excluded and the possible use of a patent medicine, be it goitre cure, cough cure, corn cure, white ointment, or tonic mixture is reluctantly acknowledged, the remaining cases to be ascribed to iodized salt will become extremely few in number. Were compulsory iodization of all salt in force a smaller proportion of iodine would almost certainly be adequate, but the monetary saving would be negligible. The larger quantity of iodine seems more desirable under present circumstances where it may be somewhat irregularly used as table salt.

In default of a national program it must fall on every physician to advocate the widest possible use of a suitable preparation of iodine by the public. It should not be forgotten that the situation calls for prevention of iodine deficiency rather than cure o its long-continued effects, and that prevention for the young begins with adequate iodine intake by the pregnant woman. One of the most valuable uses to which a prenatal clinic could be pu would be the training of the expectant mother to use sufficien iodine both for her own good health and for that of the child. I iodized salt were not used one-fourth to one-half a grain of sodium iodide weekly during pregnancy and the lactating period woul prevent congenital goitre and start the infant with enough o this essential food. Such a dose, however, would exceed by man times the adult requirement even at the other physiological epochs and continuous use of iodized salt at the table (not in the cooking may be recommended instead.

THE NUTRITIVE VALUE OF CANNED FOODS*

By L. B. Pett and M. M. Cantor

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XII.

In ancient times man met the need for preserving foods by smoking, drying or salting. In modern times new methods have been developed, using low temperatures (freezing, refrigeration) or high temperatures (boiling, canning). By canning we mean the heat-processing of food in closed containers. Although Spallanzani had shown in 1775 that meat broth could be preserved if heated in corked glass bottles it is Nicolas Appert who is considered the founder of modern canning. Stimulated by problems arising from the Napoleonic wars, Appert succeeded from 1800 to 1810 in preserving a wide variety of foods by heat-processing in corked flasks. From 1810 to 1840 the tinned iron container was developed in England and introduced to America, and home-canning also began. About 1878 the pressure cooker was first used, permitting heat-processing at higher temperatures than boiling. From 1900 to 1910 automatic machinery was introduced, and commercially canned foods began to be used commonly.

THE CANNING PROCESS

The idea is essentially the same in home and factory. Some selection of the raw material is made, followed by cleansing. Almost all products receive some heat treatment before being put in containers. This may vary from a light scald or blanching to prolonged boiling. Filling, along with syrup or brine, is then carried out into sterilized containers. This may be done while hot, and the container may be sealed at once or later. Subsequent heating for a final sterilization is usually performed. Commercial canning has the advantage over home canning in the last steps, because all air can be driven out, and subsequent heating of the hermetically sealed can is more easily carried out.

The old objections to cans as containers are invalid. While occasionally considerable quantities of tin, iron and lead (from solder) have been reported in the contents, this is not a frequent occurrence, and has never clearly been the cause of trouble. There is, further, no experimental reason for not temporarily leaving the contents in the can—which is likely to be the most nearly sterile dish in the kitchen.

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NUTRITIVE VALUES

Only in recent years has any concern been expressed about the food values of the canned product, and the industry itself is very active on this point. Unfortunately raw materials, even of the same grade, vary greatly in composition. Then, too, the canning process affects variably the same constituent in different foods, and different constituents in the same food. General statements are therefore difficult to make, and often unwarranted. The only safe procedure in evaluating a food stuff is the use of analyses of raw, cooked and canned samples. Such analyses show the range of values possible and the losses that have been found.

The table with this paper presents all such analyses that have been found and considered reliable, but it is very incomplete. The term "pulped canned food" is introduced to indicate food which has been comminuted, especially by forcing through fine openings. Essentially the same analytical results are indicated by such terms as strained, sieved, puréed, and homogenized. A few genera comments may be derived from the table.

THE STABILITY OF VITAMINS UNDER CANNING

Vitamin A, being fairly stable to heat in the absence of air is only slightly destroyed by canning; the losses vary from 10 t 50 per cent, depending on the product concerned, and are the sam in home or factory.

Vitamin B_1 is appreciably destroyed in all cooking and canning Acid products preserve it best—the loss being 5 to 15 per cent, bu in alkaline 80 per cent may be lost.

Vitamin C is the least stable of all vitamins, but owing to th occurrence of precursors or combined forms it is quite stable t canning in some foods; in other cases it is completely destroyed.

Vitamin D is fairly stable in milk; it is not important in mos other foods.

Vitamin B_2-complex is quite stable to heat. Riboflavin an nicotinic acid are destroyed in canning only to the extent of 5 t 20 per cent.

LOSS OF MINERALS IN CANNING

Calcium and phosphate precipitate during the canning many foods, and the precipitate is lost because it settles out, adheres to the metal, or is insoluble in the gastro-intestinal tract

Iodine is lacking in canned foods, except sea foods, becau canning districts are usually in goitre belts.

Table Showing Available Analyses of Raw, Cooked and Canned Foods, with Respect to Vitamins A, B_1, C, D, G, Caloric Content, Calcium, Phosphorus, and Iron

All figures are for 100 grams, or about 3½ ounces, of edible portion, regardless of the water content. Vitamins A, B_1, D are in International Units; vitamin C is in milligrams; vitamin G is in Sherman-Bourquin Units. Minerals in grams. "Pulped" refers to finely divided food. The figures are chiefly from publications by the United States Government and the Medical Research Council of Great Britain, and numerous calculations from original papers.

Foodstuff	*Vitamins*					*Calories per 100 g.*	*Ca percentage*	*P percentage*	*Fe percentage*	*Approximate measure of 100 g.*
	A Int. Units	*B1 Int. Units*	*C mg.*	*D Int. Units*	*G Sherman Units*					
Daily requirements										
Child	2,000- 6,000	200	5-15	200-600	?600	1,500-4,000	1.00	1.00	0.015	
Adult	6,000-15,000	300-500	10-50	?300	?600	1,800-5,000	0.70	1.30	0.015	
Apples:										
Raw	0-119	7-10	0-10		10-20	60-125	0.004-0.007	0.007-0.012	0.0003-0.005	2″ diam.
Cooked			0.5			124	0.002-0.009	0.008-0.015	0.0016-0.004	½ cup
Stored	0		0.2							
Canned	0		0-2			40-60				
Canned, pulped			0			60	0.012	0.019	0.0014	
Apricots:										
Dried	5,000-8,000	9-44	0-25		40-125	200-300	0.066-0.100	0.117-0.118	0.004-0.008	25 halves
Dried, cooked	1,000-2,000	0-30	0			128	0.018-0.050	0.032-0.060	0.002	4 halves
Canned, whole	3,000-5,000		0			40-130			0.009	6 halves
Canned, pulped			0			60	0.012	0.019	0.0014	⅓ cup

TABLE—*Continued*

Foodstuff	*Vitamins*					*Calories per 100 g.*	*Ca percentage*	*P percentage*	*Fe percentage*	*Approximate measure of 100 g.*
	A Int. Units	*B$_1$ Int. Units*	*C mg.*	*D Int. Units*	*G Sherman Units*					
Asparagus:										
Green	500-1,000		1-40			22	0.025	0.039-0.600	0.001	7 stalks, 5 in. long
Bleached	0									
Cooked			0-25							
Canned			1-40			20-30	0.105-0.254	0.60-0.82	0.010-0.001	
Beans:										
Dried, white		40-100	0-1		10-30	330	0.161	0.484	0.007	½ cup
Canned, white or baked						128	0.062	0.184	0.002	
String, raw	400-1,000	15-40	1-12		25	30-40	0.046-0.085	0.052-0.318	0.001-0.006	¾ cup
" cooked			0-5				0.019	0.046-0.100	0.0017-0.0024	
" canned		5-15	0-4		25					
" canned, pulped	7,000-10,000	10	0-3		20	25	0.052	0.031	0.001	⅓ cup
Lima, dried	0		10-15		100	350	0.071	0.338	0.009	⅔ cup
" canned		35	5-6		100	70			0.002	¾ cup
Soy, ground	400	100-700	0		900	400-417	0.200	0.450-0.580	0.0007	½ cup
Beets:										
Raw	0-15		5-20		40-50	40-50	0.029	0.039	0.0009	2 of 2″ diam.
Cooked			2-8							
Canned		5	5			40-50				
Canned, pulped		3	3-4			30-40	0.017	0.037	0.0016	

Beet greens:										
Raw	10,000		30-40		250	27			0.003	
Broccoli:										
Raw	1,000-10,000	30-60	15-60		100-400	32	0.22	0.070	0.0014	1 cup
Cooked	300		20							
Canned		17			100					
Cabbage:										
Raw	0-100	40-60	15-40		30-60	20-30	0.045	0.029	0.0004	1 cup, chopped
Cooked			2-30			8	0.042	0.027	0.0003-0.0006	
Canned					7					
Carrots:										
Raw	1,000-7,000	20-80	1-7		30-60	40-50	0.056	0.046	0.006	3 - 6″ long
Cooked			1-8			24	0.007-0.040	0.004-0.018	0.0004-0.002	
Canned, pulped	6,000-7,000	10			7	30	0.029	0.029	0.001	⅓ cup
Cauliflower:										
Raw	40-50	110	6-40		50-60	20-30	0.123	0.061	0.0009	1 cup
Cooked	10-20	22	0-30			10-15	0.023	0.033	0.0005	
Canned						20				
Celery:										
Raw	0-1,000	10-20	3-6			10-20	0.050-0.078	0.032-0 037	0.0006	3 - 6″ stalks
Canned, pulped						10-20				
Cherries:										
Raw	100-500		3-20			50-80	0.015-0.019	0.016-0.031	0.0004	20 cherries
Canned			2-5			40-70			0.0012	

TABLE—*Continued*

Foodstuff	*Vitamins*					*Calories per 100 g.*	*Ca percentage*	*P percentage*	*Fe percentage*	*Approximate measure of 100 g.*
	A Int. Units	*B1 Int. Units*	*C mg.*	*D Int. Units*	*G Sherman Units*					
Corn, yellow:										
Raw	100-1,000	100	3-10	0		100	0.006	0.103	0.0005	2 - 6″ ears
Cooked			2-5							
Canned	1,000	30	8			80-100			0.0005	2/5 cup
Cranberries:										
Raw	20	0	8-30	0	0	50	0.017	0.011	0.0004	1 cup
Canned			3-5			180				
Grapefruit:										
Raw	0	14-40	2-50		40	30-50	0.017-0.021	0.016-0.020	0.0002-0.0003	½ cup of ½″ pieces
Canned	0-15	2	30-40		5	30-60				
Grapefruit juice	0		2-65			20-30				¼ cup
Canned			30-40			50				
Lemon juice	0		20-70			10-40	0.008-0.024	0.010	0.0002	½ cup
Canned			46			20				
Milk:										
Raw, whole	100-400	20-30	1-3	0-10	50-100	69	0.120	0.093	0.0002	⅜ cup
Condensed (sweetened)			0-2			330	0.300	0.235	0.0006	⅓ cup
Evaporated	500	23	0-1	27	200	130-150	0.250	0.200	0.0005	⅜ cup
Irradiated	200-300			270-500						

Oranges:										
Raw	65	60	10-60		20-40	40-60	0.045	0.021	0.0005	2″ diam. (No. 288)
Canned	40		40			40-60				
Orange juice	60	20-30	10-80		30	40	0.012-0.029	0.016-0.024	0.0004	½ cup
Canned			30-50			50-70				
Peas:										
Dried	200-1,000	140	0-10		90	300	0.033-0.084	0.268-0.400	0.005-0.0057	½ cup
Raw	400-2,000	40-300	4-40	0	100-200	100	0.015-0.028	0.104-0.127	0.0019-0.0021	¾ cup
Cooked			0-14			120	0.012-0.026	0.021-0.083	0 0004-0 0016	
Canned	1,000-10,000	40-75	5-13		100	40-60	0.020	0.080		½ cup
Canned, pulped	9,000-11,000	25-30	3-4		29	50-60	0.012	0.083	0.0016	⅓ cup
Peaches:										
Raw, with stone	50-1,000	3	1-8		18	40-50	0.005-0.016	0.019-0.024	0.0003	2½″ diam.
Canned	200	0	3-4			30-40			0.0011	
Pears:										
Raw	0-20	10-40	1-5		20-100	40-60	0.007-0.015	0.010-0.026	0.0002	1 large
Canned	10	1	3			30-80			0.0007	
Pineapple:										
Raw	10-100	25	5-30		20	40-60	0.018	0.008-0.028	0 0004	1 - 1″ slice
Canned	40-100	20-80	5-10			50-100			0.0001	
Pineapple juice:										
Canned			5-20			60				½ cup
Prunes:										
Dried, cooked, with stones	500-1,500	10 50	0-1		10-100	80-130	0.015	0.030	0.0008	4 prunes
Canned	1,000	3	0		5	80-130				⅓ cup
Salmon, canned	100-400	10-30		200-800	80	150-200	0.024-0.075	0.250-0.320	0.0008-0.0016	¾ cup

TABLE—*Continued*

Foodstuff	*Vitamins*					*Calories per 100 g.*	*Ca percentage*	*P percentage*	*Fe percentage*	*Approximate measure of 100 g.*
	A Int. Units	*B1 Int. Units*	*C mg.*	*D Int. Units*	*G Sherman Units*					
Sauerkraut	0	20	0-10		20	20-30				⅔ cup
Canned	0-100	20	0-1			20				
Sardines, canned	100-10,000	30		1,000-5,000		200-300	0.025-0.409	0.260-0.683	0.004	10 sardines
Shrimp, canned	1,000	0-40		100-500		111	0.028	0.292	0.0027	20 shrimps
Spinach:										
Raw	600-700	12	10-80		20					
Cooked	1,000-28,000	50-60	0-12	0	40-150	22-30	0.060-0.560	0.020-0.100	0.0026-0.0036	⅔ cup
Canned	5,000-15,000	2-10	5-7		7	10-20	0.062	0.026		
Canned, pulped	12,000	4-6	7-9			20	0.057	0.039	0.001	⅓ cup
Strawberries:										
Raw			20-70			36	0.022-0.041	0.023-0.028	0.0007	½ cup
Canned	20	4	25			30-50				
Tomatoes, red:										
Raw	500-1,000	20-60	15-35		12	20	0.011	0.026	0.0004	2″ diam.
Cooked	500		0-20							
Canned, whole	100-1,200	20	5-22		10-15	20			0.001	½ cup
Canned, pulped	2,000-5,000	25-45	5-11		21	20-40	0.013	0.030	0.0016	
Canned, juice	1,000-5,000	11	0-25		15	20-30	0.005	0.017	0.0008	½ cup
Canned, soup			9			50			0.0022	
Turnip greens:										
Cooked	1,500-10,000	30-50	20-100		100-200	32	0.098-0.347	0.045-0.049	0.0035	¾ cup
Canned		3	10		5	20	0.170	0.050	0.0014	

Home-cooking

Most canned foods must again be heated in the home. The wise advice that this be done in the can is rarely followed, and further losses are certain to occur, mostly from oxidation.

Conclusion

The high standard maintained by manufacturers in selecting and handling the raw materials suggests the superiority of canned products over the poor grades of raw products. Nevertheless, it is best to refer to actual analyses showing observed losses of the particular food constituent under consideration. Since many canned foods must again be cooked in the home, further losses from the stated values will be observed. This fact tends to bring the food value of canned foods even lower than raw foods, which receive only one heat treatment. In such cases canned foods may sometimes be justified on grounds of convenience or price rather than on their food value.

NUTRITION AND RESISTANCE TO DISEASE*

By Elizabeth Chant Robertson
and Frederick F. Tisdall

Toronto, Ont.

XIII.

Nearly a hundred years ago Graves wrote, "Want of a sufficiency or food of an unwholesome or an improper character predisposes the human frame to disease by its debilitating effect on the system". It is interesting to note that some physicians in the past recognized and emphasized the rôle of nutrition in the maintenance of health and resistance against infection. No one now questions the rôle of proper nutrition in resistance against disease. from a clinical standpoint, possibly most of us think of it in terms of under-nutrition rather than of malnutrition. The difficulty of obtaining clinical evidence of the effect of minor nutritional deficiencies is obvious. The story is entirely different however in regard to animal laboratory experiments where all conditions can be adequately controlled.

There is evidence that a lack of almost any one of the 32 food elements essential for animal nutrition will result in a lowered resistance to infection. A number of experiments giving evidence of this nature have been reported by one of us (E.C.R.). The procedure developed was to feed animals with a measured amount of a disease-producing organism and note the number of animals that survived. This sounds like a very simple procedure, but actually it constitutes a most difficult and time-consuming experiment. A suitable disease-producing organism had to be first obtained. After a number of trials, an organism called *Salmonella muriotitis* (rat typhoid) was found to be suitable for this type of study. It was comparatively harmless for the human being, but in suitable doses was found to be pathogenic for the rat and yet not so severe in its effect that it invariably killed all animals. When death occurred it was preceded by marked diarrhœa, cyanosis, and a bloody discharge from the nostrils. Blood cultures were taken aseptically from the hearts of all the dead animals and the organism was regularly recovered, usually in pure culture, indicating that the rats had a muriotitis septicæmia when they died.

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*From the Department of Pædiatrics, University of Toronto.

The animals were observed for 28 days after the infecting dose, when the experiments were terminated, and those that lived for this length of time constituted the survivors. When death occurred it usually was within the first ten days. The degree of resistance was estimated by the percentage of survivors in each experiment. In every case the experimental animals were fed a diet adequate in all respects with the exception of the factor or factors being studied. Control litter mates were fed the same diet with the addition of the substance under study.

In Table I is shown the effect of lack of vitamin A on resistance to infection. It is to be noted that when the diet was deficient in this vitamin only 40 per cent of the animals survived as compared to a survival rate of 79 per cent in the litter mates who were fed the same diet with added vitamin A, in the form of its precursor, carotene.

TABLE I.
THE EFFECT OF A LACK OF VITAMIN A (CAROTENE) ON RESISTANCE TO INFECTION

Vitamin A deficient diet	
No. of animals	10
No. of survivors	4
Survivors	40 per cent
Vitamin A deficient diet, plus 0.5 per cent. carotene solution	
No. of animals	14
No. of survivors	11
Survivors	79 per cent

In Table II it is seen that when the diet was lacking in the vitamin B complex 20 per cent of the animals survived, as compared with a survival rate of 72 per cent when the diet was perfect in all respects.

TABLE II.
THE EFFECT OF A LACK OF THE VITAMIN B COMPLEX ON RESISTANCE TO INFECTION

Vitamin B deficient diet	
No. of animals	79
No. of survivors	16
Survivors	20 per cent
Vitamin B deficient diet plus 6 per cent yeast	
No. of animals	72
No. of survivors	52
Survivors	72 per cent

Similar results were obtained, as shown in Tables III, IV and V, when the diets were lacking respectively in vitamin D, minerals, and animal protein. In Table V it should be noted that the first lot of animals received their protein from grain sources, while the control animals received their protein largely from milk casein. This is evidence in favour of the advisability of including in the diet each day a certain proportion of protein as *animal* protein, namely, meats, fish, poultry, eggs, milk and cheese.

In considering the percentage of survivors in Tables I to V,

TABLE III.
THE EFFECT OF A LACK OF VITAMIN D ON RESISTANCE TO INFECTION

Rachitogenic diet	
No. of animals	375
No. of survivors	106
Survivors	28 per cent
Rachitogenic diet plus Vitamin D	
No. of animals	364
No. of survivors	201
Survivors	55 per cent

TABLE IV.
THE EFFECT OF A LACK OF MINERALS ON RESISTANCE TO INFECTION

Diet very low in minerals	
No. of animals	63
No. of survivors	34
Survivors	54 per cent
Diet adequate in minerals	
No. of animals	61
No. of survivors	53
Survivors	87 per cent

TABLE V.
THE EFFECT OF A LACK OF ANIMAL PROTEIN ON RESISTANCE TO INFECTION

Normal diet with 17 per cent wheat gluten	
No. of animals	40
No. of survivors	23
Survivors	57 per cent
Normal diet with 17 per cent casein	
No. of animals	41
No. of survivors	37
Survivors	90 per cent

no comparison should be made between the number of survivor in one table with the number of survivors in another table, because with each set of experiments it was necessary to regulat the dosage of the *Salmonella muriotitis*. This was necessary because there was a variation as the experiments proceeded in th degree of virulence of the organism. However, in every individu experiment the conditions of the control animals and of the experimental animals were identical, with the exception that the diet in the experimental group was lacking in the factor or factors being studied.

In the experiments the conditions were naturally quite severe, in that the deficiencies produced were very marked. One might say that deficiencies of this degree would rarely if ever be encountered under Canadian dietary conditions. Further studies were then made in which the degree of the deficiency in the diet was comparatively slight. The results obtained in one set of experiments are given in Table VI. It is seen that with this lesser degree of deficiency there is still a marked difference in the resistance of the two groups of animals against disease. These studies with animals furnish clear-cut evidence that improper nutrition lowers the resistance of the animal to infection and also that the nutritional deficiency does not have to be so severe as to produce outstanding evidence of disease.

TABLE VI.

THE EFFECT OF A PARTIAL LACK OF THE VITAMIN B COMPLEX ON RESISTANCE TO INFECTION

Partial vitamin B deficient diet	
No. of animals	30
No. of survivors	6
Survivors	20 per cent
Same diet plus vitamin B	
No. of animals	38
No. of survivors	33
Survivors	87 per cent

With this laboratory evidence in mind, that a nutritional deficiency will result in a lowered resistance to infection, how are we going to feed our sick patients? If the illness is an acute one of short duration, simply a matter of 3 or 4 days, this question is not urgent. However, it is obvious that if the patient is suffering from any disease that lasts more than a week or so, special attention must be given to his nutrition as a whole. Strange as it may seem, this is frequently neglected. Recent work has indicated that the presence of any infection increases the need of the body for many of the food elements. To give only three examples; it has been shown that the amount of vitamin A and vitamin C in the blood is markedly lowered by infection, and there is evidence of an increased need for vitamin B_1.

The physician's duty to his patients, however, should not stop with just the treatment of the acute or chronic illness. When the patient presents himself with even some minor infection, our interest should be aroused as to why the infection developed. Was it the result simply of a focus which could have been removed or treated, or have the patient's habits been such that he is not enjoying the highest level of resistance? Probably the most important of these habits are his habits of nutrition. The remarkable adaptability of the body is such that a person may have a nutritional deficiency for many years before it clearly evidences itself. In the interval, however, the patient will not be enjoying the highest possible level of health and resistance against infection.

One should not expect that infections can be completely prevented by dietary means. This, of course, is impossible, and with many diseases there is no evidence that nutrition has any effect on the susceptibility of the patient to the disease. However, from clinical observations, there is no question that with proper nutrition the patient's resistance to disease is maintained at a high level and that he will "throw off" or recover from his infection more often and more quickly than the one who is malnourished.

One cannot lay down any rules as to the nutritional treatment of a patient during illness. However, when the patient has recovered, and there is no specific contraindication, his food should include each day a pint to a pint and a half of milk for children, one-half pint for the adult, some meat, one egg daily, two liberal helpings of vegetables besides potatoes, some raw fruit or vegetables, and, during the winter months, some source of vitamin D. If this is done, you will be assisting your patients to reach that goal which we all desire, namely, optimum resistance against infection and optimum health.

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BETTER NUTRITION AS A HEALTH MEASURE*

By E. V. McCollum

Baltimore, Md., U.S.A.

XIV.

It is indeed a great pleasure for me this evening to address the radio audience of Canada under the auspices of the Canadian Medical Association, which has recently embarked upon a broad and comprehensive nutritional program calculated to promote better health among the Canadian people.

The British Ministry of Health, through one of its Committees, has stated its belief that the full application of modern advances in the knowledge of nutrition would effect a general rising of the standard of health comparable to that which followed the lessening of disease by the development of an adequate system of sanitation. The magnitude of the benefit arising from sanitation, the prevention of epidemics, and the control of the most devastating diseases of childhood may be visualized by reflecting that the average duration of life on this continent has been extended during the 25 years between 1911 and 1935 by nearly 14 years, or by approximately 30 per cent. Better nutrition, in the opinion of enlightened medical opinion, can accomplish another great achievement in this direction, and at the same time increase the efficiency and decrease the burden of ill-health of the population with all that this means to both individual and national prosperity.

The adequate diet for the promotion of health is made up of a number of "little things". From the proteins of our foods we derive nine simple substances called amino acids, none of which we can do without. We must have at least thirteen inorganic or mineral elements: sodium, potassium, calcium, magnesium, chlorine, iodine, phosphorus, sulphur, iron, copper, manganese, zinc, and cobalt. We must have adequate amounts of the seven vitamins, A, B_1, C, D, E, riboflavin, and nicotinic acid. Probably several others remain to be discovered. We require energy from proteins, fats, and carbohydrates. If we have in our daily diet all of these "little things" we have provided for adequate nutrition.

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*Trans-Canada Broadcast, February 19, 1938.

We now know what each of our common foods provides in terms of these "little things". There are very great differences in the quality of the common things which we eat. We may eat an appetite-satisfying meal and yet fail to secure indispensable nutrients. We are eating too much refined cereal products such as white flour, other refined cereals, and sugar, and not enough of the "protective foods". By "protective foods" I mean milk, eggs, leafy vegetables and fresh fruits, and such vegetables as may be eaten uncooked. In a partial sense meats are protective foods. Most of our common foods are deficient on some of the essential food elements. We do not condemn any of them because of this, because the keynote to success in nutrition is the proper combination of foods so that what is lacking in one will be supplied by another. To provide an optimum diet, observe the following rules: (1) One pint of milk daily for each adult, or more if desired. Thirty ounces of milk for each child under 12 years. (2) Four servings of vegetables; two of them raw, as in salads, and one green. (3) Two servings of fruit, raw or cooked. (4) One serving of meat, fish, game, poultry, eggs or cheese. (5) One serving of whole grain cereal. (6) About 400 international units of vitamin D, derived from any fish liver oil, viosterol, or any medically approved concentrate.

In each individual kind of deficiency there is a definite and unique set of symptoms and mode of nutritive failure. Thus, deficiency of iron causes anæmia, characterized by pale blood and insufficient oxygen supply. Some degree of anæmia is widespread because few of our foodstuffs are sufficiently rich in iron. Vegetable foods, in particular the whole grain cereals and the tuber and root vegetables, are our best sources of iron. Much of the iron of meats is in forms not available. Anæmia results in easy fatigability and lassitude, and in lessened ability to withstand the infections.

Iodine deficiency is widespread in most countries, and is the cause of simple or endemic goitre. In 1925, 36 per cent of the school children of Michigan had enlarged thyroid glands because of deficiency of iodine. In that year a campaign was started, with the cooperation of the medical profession, to induce the people to use iodized salt. After twelve years the incidence of goitre among children has been reduced to 1 per cent, and the number of cases of goitre coming to the hospitals has steadily decreased. Reduction in the incidence of goitre has improved the comfort and efficiency and increased the span of life of many thousands of people.

Many people are taking too little of the element calcium. A merit of the type of diet just recommended is that it supplies this element in abundance. This is especially important for the development of good teeth and bones in the child, and for preventing a deficiency of calcium in pregnant and lactating women.

These three mineral elements present important practical problems. The remaining mineral elements are generally secured in sufficient amounts. However, there are good reasons for believing that, as has been shown by Dr. Elizabeth C. Robertson, of Toronto, the total intake of mineral salts in our common diets is below the amount which would be best for us. She has shown that when the mineral intake is low the intestine does not empty itself effectively. The low mineral content of refined cereals and their absence from sugar may well be in part responsible for the widespread prevalence of constipation. The diet which I have recommended provides an abundance of all the mineral salts except iodine, which should be obtained through the use of iodized salt.

Turning to the vitamins, we find eminent medical opinion supporting the view that many people do not get enough of several of them because their diets are not well chosen. I can mention only the most important practical applications.

Vitamin A is closely associated with the health of the mucous membranes lining the respiratory, gastrointestinal, and urinary tracts. Healthy mucous membranes are an effective barrier against the entrance of bacteria, and as a general health measure it pays to take a diet abundant in this vitamin. It is provided by all green and yellow vegetables, by milk, butter, liver, kidney, fish, etc., but not by white vegetables such as potatoes, white turnips and white cereal products. It is very abundant in fish liver oils.

A striking relation exists between deficiency of vitamin A and the functioning of the eye. There is a pigment called visual purple in the retina of the eye, which is, in part, made of vitamin A. When we become depleted of this substance vision is impaired. This condition is widely prevalent among people who subsist upon poor diets.

Many people, especially children and pregnant and lactating women, are not getting enough of vitamin B_1, which is necessary for the health of the nervous system. The prevalence of neuritis, poor appetite, and of the smooth, bald tongue, point to deficiency of this vitamin.

Vitamin C is found in fresh, uncooked fruits and vegetables, and in other raw and commercially canned foods. Deficiency causes scurvy, which is still fairly common in infants. The health of the blood vessels is dependent upon an adequate supply of this substance. When the body becomes depleted in vitamin C it is much more susceptible to injury by bacterial poisons which arise through infections than is the case when the body reserves are high. Arterial damage resembling that seen in arteriosclerosis seems to result from bacterial poisons in persons who run short of this vitamin.

Vitamin D is of outstanding interest in relation to health. Only twenty years ago rickets, a disease of the bones, was common. The discovery of vitamin D and its power of promoting normal bone growth represents one of the major contributions of nutritional science to public health. Now rickets in infants and children is much less common than formerly, and when the disease exists it is much milder. Now almost all mothers in Europe and America know that the baby must be given cod liver oil or one of the other sources of vitamin D. The benefits to infants and children resulting from the application of this knowledge have already been incalculable, and the boon of this knowledge is a permanent possession for the future.

There are three ways in which tooth structure may be influenced by diet. The organ which forms the enamel is very dependent for its health and function on vitamin A. If a deficiency of this vitamin occurs in the infant or child whose teeth are still forming the enamel will contain pits and fissures, which are potential food traps, in which particles of carbohydrate food lodge and ferment, with the formation of acids which dissolve away the enamel. If the diet contains an abundance of vitamin A but not enough vitamin D the content of phosphate in the blood will fall, as it does in rickets, to so low a level that calcium phosphate, the substance of enamel, cannot be laid down, and poor enamel will result from this deficiency. The dentin-forming organ is especially dependent upon an abundance of vitamin C. If an infant or child whose teeth are forming does not get enough of this factor the dentin of the teeth will be badly formed and the future health of the tooth will be impaired.

Teeth of perfect structure, free from imperfections such as pits and fissures, and with smooth, polished enamel surfaces, are far less likely to decay than are teeth exhibiting these imperfections. Hence the fundamental importance to the individual of having optimum nutrition during the period when the teeth are developing. Decay of the teeth is not only a source of discomfort, as from toothache, but also an inconvenience because of the early loss of the teeth. Tooth decay is a menace to health, since the dead tooth is frequently the source of an abscess from which bacteria or their poisons find their way into the blood stream. Secondary infections in the joints, kidneys, gall bladder, and other places, have not infrequently been traced to an infected tooth. Decayed teeth have been and are the cause of much ill health. The prevention of tooth decay would constitute one of the greatest possible achievements in improving the public health. If our present day knowledge of nutrition could be applied to the entire population there is no doubt that tooth decay could be reduced to a small fraction of its present ravages.

Optimum nutrition is so important in the minds of the leaders in the field of public health that in Europe and America a great movement is under way to improve the dietaries of the peoples. Governments are now taking active measures to provide the better-class foods at lower cost. In Canada an abundance of the better class foods are available. The great need is for the dissemination of knowledge about the selection of foods so that the daily diet will be complete.

In summary, let me emphasize that through diet we may accomplish:

1. Improvement of the health of the mucous membranes, making them more effective as barriers against the entrance of infective agents, with consequent reduction in the incidence and severity of respiratory diseases.
2. Improvement in the structure of the teeth, and reduction in their liability to decay and subsequent infection; relief in great measure from secondary infections of the joints, kidneys and heart.
3. Safeguarding the health of the nervous system, especially as respects neuritis and the secondary effects of nerve injury, such as heart and digestive disorders and disease of the digestive tract.
4. Protection of the blood vessels against injury caused by bacterial poisons acting upon them when the body's reserves of vitamin C are low.

We do not claim to have found in adequate nutrition the panacea for all human ills. We do claim that malnutrition is widespread and of a degree of severity which is reflected in many people in ill health in one of the categories mentioned. Attention to the proper selection of foods throughout life will go far toward reducing the incidence and severity of these conditions. When the body is not functioning normally, as in malnutrition, its capacity is lowered to withstand the effects of infections, fatigue, and emotional strain.

I appreciate this opportunity to speak to the radio audience of Canada on better nutrition as a health measure, and to urge upon my listeners that they cooperate with the Canadian Medical Association and with their Governmental agencies, who are intensifying their efforts to make available to all the modern researches in nutrition in the interests of better health. In emphasizing the importance of diet in relation to health I am not minimizing the importance of curative medicine, or of preventive medicine as exemplified by the work of your Health Departments. Their achievements have been most noteworthy. The science of nutrition is the youngest of the agencies which has developed among the fields of activity which play a part in the preservation of health. Organized medicine welcomes this new knowledge as another means of accomplishing its objectives.

That it is not necessary to take vitamins in pills is shown by the fact that Sampson and David and the original marathon runner derived their strength, and the Venus de Milo, Aspasia, Cleopatra and other famous women, their charm, by eating natural foods only.

About twenty years ago I coined the slogan: "Eat what you want, after you have eaten what you should." Eat every day the necessary amounts of the protective foods, and after that eat whatever your appetite calls for.

NORMAL NUTRITION*

By L. H. Newburgh

Ann Arbor, Mich., U.S.A.

XV.

People have always believed that instinct and appetite could be relied upon to guide them in the proper choice of food, but recently the chemists, being skeptics, put the matter to the test. They soon discovered that neither man nor animal possesses any hidden power that permits him to select what he needs to keep him in a healthy state or to reject what is harmful. However, the very active investigation of this question has revealed what food materials must be eaten to produce a healthy body and an active mind. Of equal significance is the striking fact that many diseases, such as rickets, scurvy, pellagra, beri-beri and goitre are caused directly by eating too little of certain substances. More subtle are the penalties of over-indulgence. We are just now beginning to realize that certain common diseases of middle life are caused by eating too much. The factors that need to be particularly considered in order to assure an adequate diet are calories, protein, the vitamins, and some of the minerals, especially calcium and iodine.

Usually the caloric intake is regulated automatically by the appetite, although many children eat too little to meet their very large demands for energy; and obesity is far too prevalent among middle-aged persons who eat too much.

The habitual food of large groups of people contains far too little protein. Thus, in the south central portion of the United States, especially in the mountainous districts, the food consists chiefly of corn, molasses and salt pork. The natives are thin, pale, haggard, devoid of ambition, and lacking in strength. It is characteristic that they accept their debility as a matter of course and evince no interest in overcoming it. Even though they are suffering from a protein deficiency instinct does not prompt them to seek out protein-rich foods. Nevertheless, the following table makes it clear that it is a simple matter to obtain a sufficient amount of protein.

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*Department of Clinical Investigation, University of Michigan, Ann Arbor.

TABLE I.

SOURCES OF PROTEIN

Amount of food that contains 60 grams

Food	*Amount*
Meat	⅔ pound
Fish	⅔ "
Poultry	⅔ "
Eggs	8
Milk	2 quarts
Cheese, Cheddar	½ pound
Cheese, cottage	⅔ "
Beans, navy, dry	⅔ "
Beans, soy, dry	⅓ "
Peas, dry	⅔ "
Bread, white	1½ pounds

It is self-evident that normal growth and development are dependent upon an intake of sufficient and proper materials in the form of food. The younger the child, the more important this question becomes, for growth is most rapid in the earliest years. The normal baby trebles its weight during its first year. It grows even more rapidly during the three months before birth. Since its food comes to it from its mother during this early period her diet largely determines the physical condition of her baby. Bones, whose chief constituent is calcium phosphate, cannot be formed unless an adequate supply of calcium and phosphorus is being absorbed from the digestive tract. Fortunately, phosphorus is plentiful in so many foods that no special thought needs to be directed towards obtaining enough of it. The situation is just the opposite in regard to calcium since its occurrence in most foods is small as compared with the considerable amount required. Sherman, who has made many noteworthy contributions to this subject, insists that the growing child should receive at least one gram of calcium every day.

The following table will convince you that the child will receive too little calcium unless it drinks four glasses of milk daily or takes its equivalent as cream, cheese and ice-cream. A pint of milk, four ounces of cream, an ounce of cheese, and a serving of a leafy vegetable will meet the demand. On the other hand, it would be impossible for the child to eat sufficient quantities of meat, eggs and white bread to obtain the desired amount of calcium. Our forbears were wiser than they knew when they cherished the cow, for she patiently and with never a complaint extracts the calcium from large quantities of grass and delivers it to us in so small a package that we imbibe it with ease and pleasure. The occasional child who is sensitized to milk need not be deprived of its quota of calcium since the physician can prescribe it as a medicine.

TABLE II.

SOURCES OF CALCIUM

Amount of food that contains 1 gram

Food	*Amount*
Milk, whole	1 quart
Buttermilk	1 "
Milk, skim	1 "
Cream, 20%	1 "
Cheese, Cheddar	3 ounces
Cheese, cottage	3 pounds
Beans, dry	1½ "
Watercress	1 pound
Chard	1½ pounds
Dandelion greens	2 "
Cabbage	5 "
Lettuce	5 "
Bread, whole-wheat	4 pounds
Bread, white	8 "
Corn meal	12 "
Eggs	20
Beef	22 pounds

Even more difficult is the problem of assuring an adequate intake of the various vitamins, because our recently acquired opportunity for obtaining a highly varied diet throughout the year is due to the refinement and preservation of foods—processes tending to remove and destroy considerable amounts of the vitamins which were present in the foods before man had tampered with them. You must realize that recognition of the existence and the importance of the vitamins is very recently acquired knowledge. Eijkman (1897) produced an illness in fowls similar to beri-beri by confining them to a diet of polished rice. He attributed the illness to the lack of some factor that was present in the whole grain, but that explanation seemed too bizarre at a time when every one was thrilled by Pasteur's great discovery that bacteria caused disease. It required the demonstration of the great English chemist, Hopkins, that purification of foods caused definite illnesses, to force the recognition of this great fact. In 1906 he wrote: "No animal can live upon a mixture of pure protein, fat and carbohydrate, even when the necessary inorganic material is carefully supplied. The animal body is adjusted to live either upon plant tissues or other animals, and these contain countless substances other than proteins, fats and carbohydrates."

The vitamins may be thought of as catalysts or enzymes. That is, their presence in minute amounts promotes and accelerates chemical reactions. Thus, the chemical engineer produces fertilizer by exposing nitrogen and hydrogen to a mixture of finely divided iron and molybdenum. The presence of the minute metallic particles causes the two gases to unite with the rapid formation of ammonia. Nitrogen makes up four-fifths of the air, but in its ordinary gaseous state it is of no value to plants.

Similarly, the familiar process of digestion is wholly dependent upon enzymes. Almost none of the food that we eat is in a state that makes absorption possible. It must first be broken down into similar units; and this fragmentation results from the contact of the food with a great variety of substances whose sole function is to assure digestion. Some enzymes are made by the body itself, but many reactions take place within the organism because of the presence of still other enzymes that the body is unable to make from any of the materials within it. It must obtain these substances in their finished form from the outside as constituents of the food. These are the vitamins. We are now ready to see how these major dietary requirements can be satisfied, but first we must learn how much of each is needed by consulting the table which lists average needs.

TABLE III.

CHIEF DIETARY REQUIREMENTS

Calories	3,000
Protein	60 grams
Calcium	1.0 gram
Vitamins	
A	+++
B	+++
C	+++
D	+++

It must be realized that there is considerable variation in the requirement for calories. Older boys will often have to take 4,000 or even 5,000 calories to complete their growth at the normal rate. With advancing age less energy is expended, so that in the period of senility, 2,000 calories may be sufficient. During the latter half of pregnancy as well as during the nursing period it is recommended that the mother should receive two grams of calcium daily.

Table IV will show you in somewhat exaggerated form the type of diet that is so common in our big cities. It is woefully lacking in calcium and in the vitamins. Robust health is precluded by disregard for milk, fruit and green vegetables. Nevertheless, an adequate diet may easily be selected by anyone who has learned the rudiments of nutrition. The following combination of foods is suggested for those of very limited means. (See Table V).

This diet is lacking in variety and interest, but nevertheless can be relied upon to supply all the elements necessary for normal nutrition. Meat has been omitted, to reduce the cost and the effort of preparation. Whole-wheat bread supplies the protein and vitamin B that would have been obtained from the meat. Butter has also been left out. It is not needed since the vitamins

TABLE IV.
AMERICAN BIG CITY DIET

Food	*Amount*	*Calories*	*Protein grams*	*Calcium grams*	*Vitamins*			
					A	B	C	D
Potatoes..............	1 pound	380	8	0.05	+	++	++	+
Flour, white...........	1 pound	1,600	50	0.10	0	0	0	0
Meat.................	½ pound	350	45	0	0	++	0	0
Sugar.................	¼ pound	450	0	0	0	0	0	0
Fat..................	⅛ pound	500	0	0	0	0	0	0
Totals.............		3,280	103	0.2	+	++	+	0
Requirements..........		3,000	60	1.0	+++	+++	+++	+++

TABLE V.

SIMPLIFIED ADEQUATE DIET

Food	*Amount*	*Calories*	*Protein grams*	*Calcium grams*	*Vitamins*			
					A	B	C	D
Milk	1 quart	700	33	12	+++	++	0	+++
Cabbage or other green leaves, or fruit	1 pound	100	5	0.2	+++	+++	+++	+++
Bread, whole-wheat	1 pound	1,100	40	0.2	+	++	0	0
Potatoes	½ pound	200	5	0	0	++	++	0
Fats—butter substitutes, lard, Vegetable fats	¼ pound	1,100	0	0	0	0	0	0
Totals		3,200	83	1.6	+++	+++	+++	+++
Requirements		3,000	60	1.0	+++	+++	+++	+++

TABLE VI.

WHOLLY ADEQUATE DIET

Food	*Amount*	*Calories*	*Protein grams*	*Calcium grams*	*Vitamins*			
					A	B	C	D
Milk................	1 pint	350	17	0.6	++	+	0	++
Cream...............	3 ounces	210	3	0.1	++	+	0	++
Eggs................	2	225	20	0.1	+++	+	0	+++
Fruits and green leaves..	1 pound	115	3	0.2	++	+++	+++	++
Flour, bread, cake, pie..	⅓ pound	550	17	0	0	0	0	0
Meat or fish or poultry..	½ pound	350	45	0	0	++	0	0
Potatoes............	⅓ pound	150	3	0	0	++	++	0
Butter..............	¼ pound	800	0	0	+++	0	0	+++
Sugar...............	2 ounces	250	0	0	0	0	0	0
Totals............		3,000	108	1.0	+++	+++	+++	+++
Requirements..........		3,000	60	1.0	+++	+++	+++	+++

A and D contained in it are plentifully furnished by the milk and the green vegetables and fruit. The cheap fats listed furnish as many calories as equal weights of butter.

When cost and time required for preparations are not primary considerations a more interesting and satisfying day's menu can be prepared from the foods listed in Table VI.

It was pointed out earlier that iodine is one of the minerals that needs special consideration. This is especially interesting since only a minute amount of iodine is required. In fact, a small pinch of it, spread out over a whole year, is more than sufficient. But, unlike the other dietary requirements, an adequate intake cannot be obtained by eating liberal quantities of certain foods. For it is a fact that the iodine content of foods is dependent upon the locality in which they are grown. In several large areas of the earth, of which the Central Plain of North America is one, the soil contains so little iodine that the local food supply is always deficient in iodine, and this condition is responsible for the high incidence of goitre in such regions. In Michigan the general use of iodized salt has proved to be strikingly successful in preventing goitre and even in curing it in the early stages. On the other hand, persons who live at or near the sea always receive an adequate amount of iodine without giving any thought to the matter.

The merits and demerits of common foods may be set down briefly as follows. A combination of milk, vegetables and fruits contains all the dietary essentials but calories. Without a radical change in our food habits it is impossible to construct a normal diet without them. Meat, poultry, fish and eggs are valuable for flavour and protein, but alone they are incapable of furnishing sufficient calcium and vitamins. White flour, refined cereals, and sugar are excellent sources of calories but have no other value. Whole-wheat flour is preferable to white flour because whole wheat contains a considerable amount of vitamin B. Fats are the best sources of calories and add flavour. None of them, with the exception of butter, has any other value.

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PROPER FEEDING AND GOOD HEALTH*

By Sir Edward Mellanby

London, Eng.

XVI.

I am glad to have this opportunity of broadcasting to the people of Canada a simple statement concerning the great modern movement to improve the physique and prevent ill-health by proper feeding. As a preventive measure against ill-health, it compares in promise with the magnificent movement in sanitation started about 1860; and, just as Great Britain led the world in that public enterprise, so also must the British Commonwealth of Nations lead in the present movement for improved nutrition. Canadian people are reputed to be among the best fed nations in the world. From my own limited observations I should say this is true: you certainly have at hand, in your large towns at least, a wonderful range of the finest foodstuffs, and there is also evidence of a sense of health consciousness in your restaurants and homes. Superficial observation also suggests to me that your nutritional condition is, in some respects at least, better than in England. For instance, you seem to me to have much better teeth and straighter legs. There is, however, no doubt that improved dietary habits in Canada, especially in the rising generation, would result in better physical and mental health, the disappearance of much sickness and physical disability, and a great reduction in the need for doctors and hospitals. Prevention of disease is infinitely better than any dramatic cure. Let us now examine this question.

Diet must be considered from two points of view, one of less importance as a practical issue because it is guided by natural instincts, and the second of much greater importance because it can only be controlled by knowledge and intelligence. The first concerns the amount of food eaten. A person must have sufficient (but not too much) food to eat, because he or she is like a steam or any other kind of engine and requires the energy supplied by the combustion of food or fuel to provide the amount expended in movement and for the maintenance of the body temperature. If he eats too little he will lose weight and ultimately die of wasting and starvation; if he eats too much he will either get indigestion or become obese. The feeling of hunger and repletion and other bodily reactions are good safeguards in determining the right amount of food to be eaten.

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*A Trans-Canada Broadcast, September 29, 1938.

When, however, we consider the quality of the food in dietary, matters are entirely different. Instinct is a poor and often a bad guide, and yet this and purchasing power controls for most people the choice of dietary ingredients. The result is that the bulk of the diet is made up of the cheaper foods—cereals like flour, rice and oatmeal, vegetable oils and lard, also sugar, jam, lean meat, pork and pulses. These foods are deficient in practically all the vitamins and in certain mineral elements, especially calcium. Nor are these deficiencies of vitamins and minerals elements made good by the large consumption of the common beverages—coffee, tea, mineral waters, beer and spirits.

There is, however, another series of foods, known as protective foods, which as a group are rich in these substances essential for life and good health. If a sufficiency of these protective foods is not eaten poor physical development and certain forms of ill health result. Protective foods include milk, butter, cheese, eggs (especially the yolk), vegetables (especially green vegetables), liver and other glandular organs, fat fish, such as salmon, herring and mackerel, fish oils (for example, cod liver oil) and fresh fruit. The most important and best of all these protective foods is milk, because it is rich in practically all the factors essential for health and good physique. Milk added to any diet improves it greatly.

The first important principle of good dietary is that the greater the relative amount of protective foods, as compared with the energy-giving foods, eaten by a community, the better is the physique and standard of health. This does not mean that cereals and other members of the energy-giving foods should be excluded from the diet, but only that they should not be allowed to form anything like the largest part (about 60 per cent in England) of the total dietary. Generally speaking, so far as town life is concerned, the poorer the people, the greater is the amount of cereal and other foods of this group eaten and the worse the standard of health and physical condition.

The second great principle of dietary is that the younger the person, the more important is it that the proportion of protective foods should be greater. It is appalling to be told, as a doctor is so often told by a mother, in answer to a question as to the feeding of children of two or three years of age that "they get what we get". The habit of giving children tea, coffee and cocoa is wrong. The normal drink of all infants and children ought to be milk, a bacteriologically safe milk containing 3 to 3.5 per cent of fat, not milk rich in cream, which often upsets them. Moreover, the modern mother ought to know that breast-feeding is much better for herself and even more for the infant than any form of artificial feeding. Statistics have conclusively shown that the death rate among artificially-fed infants is much higher than among breast-fed infants. Mothers would also be saved a great deal of trouble and anxiety if they gave their infants, even breast-fed, from the day of birth, a little cod liver oil (say a small teaspoonful). All breeders of dogs and poultry know this trick and how much loss it saves them, and it is high time all mothers knew and practised it.

Right up to the end of adolescence the daily milk intake ought not to be less than one pint, and two pints would be much better. Those in authority over children and over boys and girls living in institutions should see to this. Tissues are growing rapidly at this time and require plenty of available bricks, best supplied by milk, for this construction. The bones especially need an abundance of calcium and, if they do not get it, become imperfectly hardened, producing in infants and young children rickets with deformed bones and, in those older, bones which easily fracture; the teeth also are badly formed and more liable to decay. The teeth of civilized man are probably his greatest curse; milk, egg yolk and cod liver oil will help to produce good teeth and to prevent dental decay; too much bread and other cereal foods and sugar hasten its onset.

Statistics show that more eggs are eaten per head of population in Canada than in almost any other country. This is excellent. Egg yolk is a fine protective food, being rich in most of the vitamins and a good source of calcium and iron. Egg yolk, vegetables, meat and lightly milled cereals provide iron to the body and prevent anæmia. The great value of sea fish is that it is the only natural food rich in iodine, and, by virtue of this, prevents simple goitre when given to the growing child and adolescent. Cod liver oil is also valuable for this purpose. In a country like Canada where large numbers of people live a long way from the sea and goitre may be common this fact is of greater importance.

It is difficult to lecture the adult on his food. At this stage of life eating is one of the joys of existence, and he generally prefers, so long as he is feeling well, to eat what gives him pleasure rather than what is good for him. He would be well advised, however, to follow the general principles enunciated previously—to include a pint of milk in his daily diet and to look with favour on eggs, green vegetables and other protective foods. He would then be a much fitter person and his days of chronic ill health, which come ultimately to most of us, would be delayed. Some people avoid milk because they say it makes them fat. So it does, if it is ingested simply as a drink like water with no food value. Milk has, of course, a high energy and food value apart from its vitamins and salts. It ought to *replace* some of the bread, sugar or other energy-bearing foods such as cakes, biscuits and chocolate, or even beer and whiskey. With well-to-do persons over 40 living a sedentary existence milk might well replace two of the three lots of meat of all kinds they commonly indulge in daily.

There is one type of adult who demands special attention, namely, the pregnant and nursing woman. Her food has to supply not only her own body needs but also the material for the growth of her offspring in the uterus during pregnancy and for the milk supplied to the infant during lactation. If she does not get a good supply of protective foods to sustain her the drain on her reserves of certain chemical substances ultimately brings about ill health. She becomes listless, tired and anæmic, some of her teeth decay, and she suffers from cramps, restlessness and sleeplessness. Ill health during pregnancy is far too common. As a natural physiological process it ought to be compatible with good health. To reduce or avoid ill-health the pregnant and lactating woman ought to include in her diet two pints of milk daily throughout pregnancy and eat plenty of green and other vegetables, some fresh fruit, the yolk of one or two eggs daily, meat once a day, sea-fish about twice a week and a little cod liver oil daily (say a teaspoonful) if she can take it.

A few additional points may be mentioned. Most vitamins are resistant to reasonable heat, and, therefore, the cooking of food does not greatly spoil its vitamin content. Exceptions to this statement are fruit and vegetables, which on cooking lose, in most cases, their vitamin C. Potatoes are an excellent food, and have a number of advantages over cereals, so that they can well be used as a substitute for bread, especially in the case of children. Milk is much better than the butter which is made from it. Butter has some excellent qualities, but has lost many of the valuable constituents of milk itself.

You may have noted that I have not made any mention of vitamin concentrates now so abundant on the market and so extensively advertised. In ordinary health they are unnecessary, as a sufficiency of vitamins can be obtained from the foods mentioned.

Complexity of dietary is not needed for the maintenance of good health. Some communities living on the simplest dietary are the healthiest in the world. Take, for instance, the inhabitants of Tristan da Cunha, a small community living on an island in the South Atlantic. Here, until recently, when a small amount of flour has been imported, there was no bread or other cereal to eat; all the infants were breast-fed for long periods, and the main articles of diet were milk, mutton, fish, eggs and potatoes. There is no rheumatism or arthritis on the island, and there is no rickets; the teeth are almost free from decay and incomparably better than in Canada, and there has never been a death in childbirth. Similar, but not identical, conditions used to hold in the Western Hebrides and Labrador, but the advance of so-called civilization and especially the easier access to our own articles of diet, including white flour and sugar, have changed all this. In the island of Lewis it was recently found that the further away the people were from a store, that is to say, the more they had to depend for sustenance on the natural produce of the sea and land, the better teeth they had.

Finally it must be remembered that a good deal of bodily discomfort and ill health is due to overfeeding. The fat person is physically unfit. He is the right person to slim. On the other hand, the girl or young woman who slims consistently is looking for trouble, and the high death rate due to tuberculosis at this age will only be reduced when her feeding habits are healthy and she leads an active physical life.

These, then, are the simple teachings of modern nutrition. Parents and others controlling the diet of young people, in whose hands the future lies, may or may not make use of the new knowledge for themselves, but they ought at least to see that their offspring and the rising generation get a chance, the only chance, of attaining a far better state of physical and mental development and health than they themselves possess. For, whatever any government can do, the solution of this problem lies ultimately in the hands of the individual members of the community. Public authorities can certainly direct their agricultural and economic policies so as to increase the supplies of protective foods, reduce their cost, and even supply some free of charge or at specially cheap rates to the more indigent. None of these actions, however, is sufficient unless the public choose to eat the health-giving foods. It is the purpose of this brief statement to explain why people should consume greater quantities of the protective foods, especially during the earlier years of life, and to assure the public of the benefits to health that would follow. The subject of diet and its relation to good nutrition and health is beset by faddism and quackery and tends to be discredited. What I have attempted to tell you now is not faddism but is based on the results of modern scientific investigation.

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NUTRITION PROBLEMS*

DIETARY REQUIREMENTS FOR HEALTH

BY SIR JOHN BOYD ORR

Aberdeen, Scotland

XVII.

When I was a medical student about 30 years ago we did not worry very much about what kind of food we ate so long as we liked it. We assumed that if people had plenty of food to satisfy hunger they would be all right. Nowadays there are very few of our people who cannot get plenty of food. In Great Britain practically nobody is suffering from hunger, and I suppose the same must be true of Canada.

Well, if people have plenty of food to eat, why are we now making such a fuss about nutrition? Why have the Canadian Medical Association set up a Committee on Nutrition to try to improve the diet of the people of Canada? Why have similar committees been set up in Great Britain, in the other Dominions, and in about twenty other countries of the world? The reason is that in the last few years a lot of remarkable scientific discoveries have been made about the effect of food on health. We have found out that our food must do more than merely satisfy hunger. It must supply a sufficient amount of about thirty different substances, including the vitamins and the mineral salts which our bodies need. If the food we eat does not supply sufficient of every one of them then we are not as strong and healthy as we should be.

Let me give you some examples of these substances. The body needs calcium salts not only for the bones and teeth but also for the blood and all the soft tissues of the body. If the blood does not contain a definite percentage of calcium the digestive system, the nervous system, and even the heart cannot function properly. Children need a big supply of calcium, because in addition to keeping the amount in the blood at the right level they need enough to build up their growing bones. Now, if the food does not contain sufficient calcium the bones remain soft and the children get the disease we call rickets.

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*A Trans-Canada Broadcast, April 18, 1939.

But they need more than calcium salts. The food must contain sufficient vitamin D, because without this vitamin the body cannot use the calcium, no matter how much is in the food. Twenty years ago more than half the children in the poorer districts of our industrial towns in Northern Europe suffered from rickets, many of them so badly that the bones of their legs were twisted out of shape.

When we got this new knowledge of the effect of food on health we began to make an effort to improve the diet of our children to prevent rickets. We gave them more milk because milk is the richest source of calcium. We gave them cod liver oil because cod liver oil is rich in vitamin D. And as the result of that improvement in the children's diet rickets, at least bad cases, has almost disappeared.

The lack of calcium and vitamin D not only causes rickets but it prevents the children from growing as fast as they should. Giving them more milk and cod liver oil has made them grow so much faster that today children leaving school in Great Britain are about two inches taller than what their parents were at the same age. You can see why it is that we are now anxious that people should have not only sufficient food but that they should also have the right kinds of food, a diet which will supply all the different substances which the body needs.

Let us take another mineral—iron. Iron is needed for the blood. If there is not sufficient in the food the body becomes anæmic. Women need more iron than men. In a recent investigation it was found that over 25 per cent of the women in some districts suffered from anæmia due to the lack of iron. These women were easily tired; they were listless; they were often irritable and melancholy. An anæmic woman is not usually a very pleasant person to live with.

A famous lady doctor in England who made a special study of anæmia in women noted that when the anæmia was cured by making the diet rich in iron the women became much more cheerful —they began to feel that life was worth while living. They began to take more interest in themselves and to dress better. She says what struck her was that many of them went out and bought new hats!

I mention this because it is an illustration of the effect of health on our outlook on life. If we have perfect health we get a "kick" out of life; we are 100 per cent alive. A healthy person is usually a cheerful person, full of the joy of living which accompanies health.

Now, let us consider some of the vitamins. Vitamin A is needed for the mucous membranes lining the digestive tract, the respiratory tract, and the urinary tract. If the diet does not contain sufficient the living cells of these membranes cannot function properly, and the resistance of the membranes to the entrance of bacteria is weakened. It is believed by many physicians that vitamin A is of great importance in increasing the power of the body to resist some diseases, and, therefore, if we have sufficient vitamin A in our food we suffer less from some infections than if our diet is deficient in this respect.

There is an interesting connection between vitamin A and the ability of the eye to adapt itself to very poor light. It was found in some districts in towns in Europe that many children showed slowness in adaptation. When these children were given cod liver oil, which is rich in vitamin A, in most cases the rate of adaptation came up to the optimum level. We think therefore that many diets contain too little of this vitamin.

Another vitamin has been named vitamin B. This really represents a whole group of vitamins. B vitamins are needed to keep the nervous system and the digestive system in good order. If the food does not contain sufficient, we get poor appetites, digestive disorders, and some forms of neuritis. We are not quite sure yet how much of these B vitamins is needed, but there is evidence that many diets do not contain sufficient, because when we improve the diet of some children by giving them yeast or whole-grain cereals, or other foods rich in B, they grow faster and are healthier. In some cases, nervous and gastric disorders are cured when the diet is made richer in these vitamins.

We will consider one more vitamin, vitamin C. It is needed to keep the walls of the blood vessels healthy. If the food does not contain sufficient we suffer from scurvy. Scurvy used to be very common among infants, and is still liable to occur when children do not get some fresh fruit or vegetables every day. Nowadays scurvy is not so often seen, because every well-fed infant gets some orange juice or other fruit juice as a daily routine.

These are illustrations of some of the more important food constituents and of the kind of ill-health which occurs when the diet is deficient in them.

Now the important question is, how much of these constituents does the body need to attain perfect health? I won't worry you with a lot of uninteresting technical details. I will give you an illustration of the kind of diet which will provide sufficient of everything for, say, a child of about 6 or 7 years of age. I am giving an illustration of the diet for a child instead of for a man, because children need a special supply of these constituents to support growth, and mothers need a special supply to support their unborn or nursing infants. The diets of mothers and children therefore need to be richer in vitamins and minerals than the diet of men. If you are going to build up a healthy family, the most important person in the house is the mother. With regards the rest of the family, the younger the child, the more important is its diet.

Here is the kind of diet needed for a child of about 6 or 7 years of age:

1½ pints of milk,
1 egg,
1 ounce either of fish, or of cheese, or of liver, or of meat,
4 ounces of green leafy vegetables, such as cabbage, or lettuce, or spinach,
6 ounces of potatoes and other root vegetables, such as carrots, turnips and squash,
Some raw fruit or raw vegetable, and—especially in wintertime in northern districts—1 teaspoonful of cod liver oil.

Such amounts of these foodstuffs would supply all the protein all, the minerals, and all the vitamins which the child needs to protect it against the ill effects of deficiencies. They would supply two-thirds of the total amount of food needed for the child, and the rest of the diet could be made up according to appetite with the cheaper foods, such as bread and other cereals, and butter and other fats.

Now, I do not suggest that every child should be given exactly this diet; the requirements for different children vary. This is only an example. A thousand diets as good as that could be made up with different proportions of these foodstuffs, or even with foodstuffs not mentioned. But any diet fully adequate for health should contain the same large proportion of the protective foods, such as milk, eggs, fruit and vegetables.

If we could ensure that every person had a diet as good as this a great deal of ill-health would disappear, and we would rear a race of children with sound constitutions and sound teeth. They would not only be healthier children, they would be more beautiful children. Their strong bones and vigorous muscles would give them graceful movements and an erect carriage. They would have clear skins, clear eyes, and glossy hair. As a matter of fact, real beauty is merely the outward reflection of inward health.

Of course I am especially interested in Scotland, which sent so many pioneers to build up Canada. There is as good blood in Scotland as ever came out of it, and we are determined that that fine Scottish blood will get its full chance to develop through good diet to good health. I hope in my day to see every child in Scotland getting a diet as good as the one I have referred to.

Now, what about Canada? You Canadians are a husky people, but I know from investigations which are being made in Canada that you also have a considerable part of your population whose diet and health is not up to the new standard. If you are going to have a strong and healthy nation see that not only the children but the whole population apply in a practical manner the remarkable recent discoveries in the science of nutrition. As already mentioned, this can be done very simply. See that your child receives an adequate supply of the "protective foods", such as one and a half pints of milk a day, an egg a day, some meat, a liberal supply of vegetables, some raw fruit, and (in the wintertime) cod liver oil.

It is the right of every citizen of our great British Empire to enjoy the benefits of this newer knowledge of nutrition so that the health of every one of His Majesty's subjects will be up to the level which we now know is possible.

GOOD NUTRITION*

By E. P. CATHCART

Glasgow, Scotland

XVIII.

What do we understand by the term "state of good nutrition", and how are we to attain to this desirable state? It is usually assumed that the state of good nutrition and of being or looking well fed are the same thing. This is far from being the case. There is more danger in the modern world, where food is plentiful, of being overfed than underfed. A common belief is that the usual cause of malnutrition is lack of adequate food, and although this may be one of the causes it is by no means the only one. A person may be in a state of malnutrition from overindulgence in food. Although a proper supply of food, adequate alike in quantity and quality, plays perhaps the most important rôle in the development of the state of good nutrition there are many other factors which influence, and even determine, this desirable state of well being. Thus in addition to food there must be adequate sleep, fresh air, exercise, contentment of mind, and so on. You all realize the ill effects of lack of sleep, the depression resulting from lack of fresh air, for some, at least, the loss of energy when exercise is curtailed, and the feeling of ease and lightheartedness associated with contentment of mind. The mind, the spirit, the psyche, call it what you will, plays an enormous rôle in the perfection of nutrition. There is a very intimate relationship between the soundness of the mind and the soundness of the body. I have been trying to make clear to you that the state of good nutrition and fitness is a very complicated process about which we know little scientifically. But what we are clear about is that the end we desire to reach through attention to the various factors known to play parts is the building up of healthy human beings, well balanced physically, mentally and emotionally, who will be capable of all the necessary adjustments to their immediate environment, be it of work or play.

It is however perfectly true that a supply of proper food is one of the essentials. When food is taken it subserves two well defined functions in the body. One of these is to supply energy to make good that which is lost in the course of every day activity. The other is to supply material for the repair of tissue broken down in the course of day to day living, and, particularly in childhood, to supply material essential for growth. But few realize the miracle that takes place within the body after the food is eaten—the conversion of dead inert foodstuffs into living tissue. This is no haphazard rebuilding in which any kind of material is utilized. A very definite selection is made of the required building stones, especially those which are derived from the very complex and varied nitrogen-containing materials called, scientifically, proteins. So far as the first function is concerned it may be stated that the great bulk of the food eaten is used for energy production. Food, as we commonly call it, is a mixture of many materials. But whether it be the humble hot dog or the most expensive items on the menu all foodstuffs can be reduced or analyzed into six components or classes of substance—proteins, fats, carbohydrates, mineral salts, vitamins and water. Of these six groups two (fats and carbohydrates) are perhaps in the main, but not exclusively, concerned with the supply of energy to the body, whereas the others are more intimately related to the repair and building up activities of the body. Most of our foodstuffs are mixtures of these various components. Thus meat consists of protein, fat and water, with small amounts of the other substances; oatmeal has protein and carbohydrate, again with small amounts of the remaining substances; egg has protein, fat and water, with traces of the other materials, and milk is an excellent mixture of protein, fat, carbohydrate, vitamins and mineral salts in solution. Each of these basic components plays an important rôle. Proteins, like lean meat, white of egg, cheese, are absolutely essential in the diet, as they are the only available sources of the nitrogen required for the building of all living tissue. But all proteins are not of equal value. The proteins which most closely resemble in chemical structure those of the tissues are the best. They are often called first class proteins; proteins present in milk, for instance, belong to this class. One of the reasons why people are recommended to eat a good mixed diet is that when first class proteins are eaten with proteins of lesser value, such as those found in cereals, they bring about an enhancement of the nutritive value of the latter; the proteins are said to be supplementary. This supplementary action is one of the justifications for eating vegetables with meat and cereals with milk.

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*A Trans-Canada Broadcast, June 28, 1939.

Although fats and carbohydrates, like starches and sugar, are in the main concerned with the supply of energy to the body, that is, they are utilized mainly as fuel, they also play an important part in other tissue activities. But fat cannot wholly replace carbohydrate in the diet, and it cannot be properly utilized by the body in the absence of carbohydrate. Carbohydrates, as a general rule, form the bulk of the diet. They are a kind of elastic reserve by means of which we equalize the varying day to day demand for food to meet energy needs.

When it is realized that over 60 per cent of the body weight is made up of water it is obvious that a plentiful supply of water is necessary to make good the daily losses. A man may live for several weeks without food, but only for a few days without water. Further, all the tissue reactions take place in a fluid medium and are associated, for the most part, with the passage of water, either into or out of the various chemical molecules.

Some five or six vitamins have been definitely identified. These vitamins play important but as yet not definitely determined rôles in normal bodily activities. Although our present knowledge enables us to cure or alleviate certain diseases which are now recognized as being due principally to vitamin deficiency, for example, scurvy from lack of vitamin C and beri-beri from lack of vitamin B_1, we are still very much in the dark about the amounts of the various vitamins which are required for the maintenance of health. It is more or less agreed that it is best to take the necessary vitamins in the form in which they are provided by nature.

The mineral salts, of which a very large variety are found in the different body tissues, are also essentials of the diet. These salts participate in almost all of the tissue activities. Excessive loss of a simple salt like sodium chloride, or common salt, during sweating is now known to account for the distressing symptoms of fireman's or miner's cramp. An ample supply of calcium or lime and of phosphorus is essential for the proper formation of bone; a supply of iron and, possibly, a trace of copper for the formation of the red colouring matter of blood, and so on. Salts are also vital for the maintenance of the proper reaction of the tissue fluids.

All this may appear to be a most complicated account of what is necessary in food, but if a good mixed diet which is ample enough in amount to meet the energy needs of the body is taken there is little risk under normal conditions of the diet proving inadequate, except perhaps as regards minerals. The diet eaten need not be elaborate. So far as our knowledge at present goes a diet of brown bread, butter, milk, cheese, vegetables, and fruit would suffice to yield all the essentials. Of these various foodstuffs milk stands in an unique position. Why is milk so praised as an article of diet? Why has it been said that "milk is the most satisfactory individual food material elaborated by nature"? Why has it been stated that "milk should form a conspicuous element of the diet of all ages", and that "almost any diet can be considerably improved by the liberal addition of milk"? Because milk contains a supply of first class protein, of fat, of carbohydrate, is one of the best and most readily available sources of calcium and other valuable mineral salts, as well as of a fair selection of vitamins. Milk in all its forms, liquid, evaporated, dried, or in the form of cheese, provided always it be clean and free from disease germs, is a most excellent physiological combination of the food materials requisite for the upbuilding and repair of body tissues.

I stated at the start of this talk that although food played a most important part in the development of good nutrition or fitness there were other factors of importance. The achievement of fitness, of good health, means more than the consumption of so much food, of getting so much fresh air, exercise, sleep, and so on. There is the non-physical side to be remembered. Malnutrition of the spirit is quite as common if, indeed, not more common than malnutrition of the body. The one reacts upon the other. So many people are vociferously demanding what they call their rights that they forget they have duties, to themselves and the community. It must not be forgotten that the attainment of fitness demands discipline. Discipline is essential for right living. Right living means health. And health is the very foundation of happiness and contentment.

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